MAY 5 1917

Engineering News-Record

A Consolidation of Engineering News and Engineering Record
McGRAW-HILL PUBLISHING COMPANY, INC.

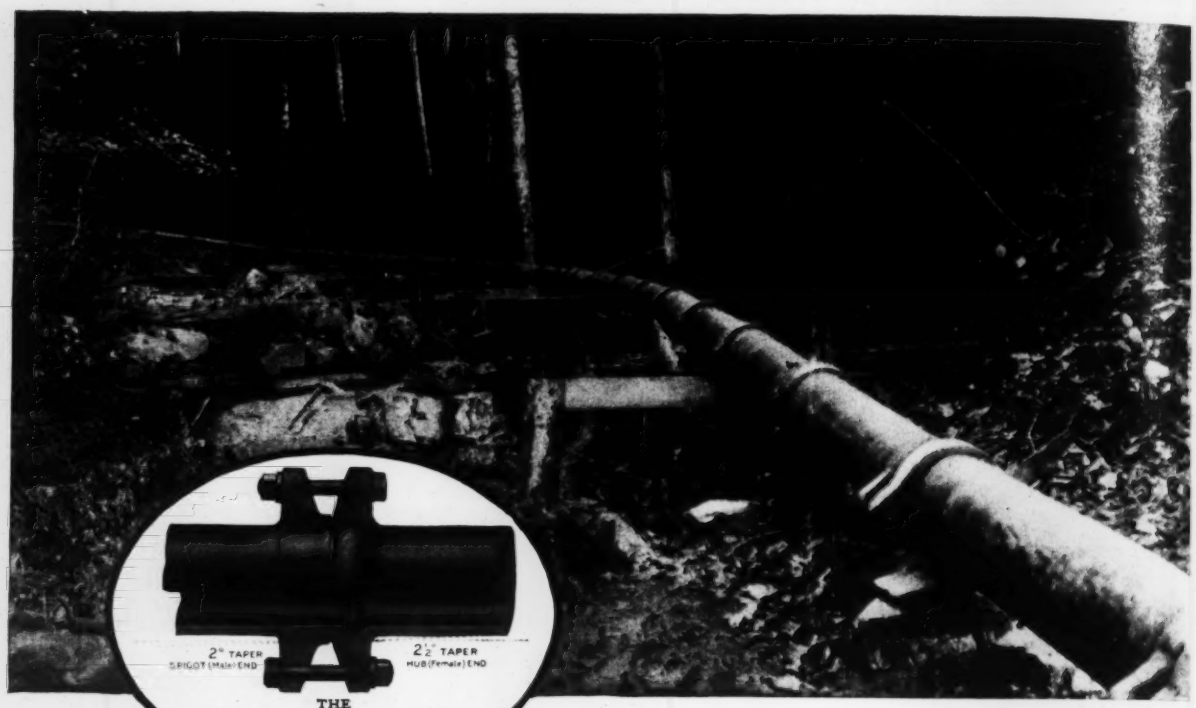
Connecting Wood Stave and Cast-Iron Pipes of Denver's Water-Works System

Notable Water-Works Articles Appear in This Issue:

Among Them Are:

New $12,000,000 Supply for Providence, R. I.—By Frank E. Winsor
Marine Type of Diesel Engine Adapted to Water-Works—By Thomas O. Lisle
Growth of Filter Sand—By Charles P. Hoover
Aeration of Algae-Laden Water at Oshkosh Filters
New Reservoir and Mains at Covington, Va.—By Harry Stevens
Use of Trenching and Backfilling Machines

Cover Released by Courtesy of Golden-Anderson Valve Specialty Co., 1202 Fulton Bldg., Pittsburgh, Pa.



NOT A JOINT LEAKED
under 270 pounds pressure

—a seven-mile pipe line winding down a mountain side and *every joint* made without calking

'The Pipe That's Different'

UNIVERSAL CAST IRON PIPE

—for Water, Gas, and All General Purposes

The hub and spigot machine-tapered joints of UNIVERSAL PIPE assure tight joints in a minimum of time with low labor cost.

—no packing—no gaskets—no tools but wrenches—

The pipe joints can be deflected and the pipe line curved with ease to suit the varying alignment of trench and fill.

TESTED AND APPROVED FOR FIRE Protection Service by the Underwriters' Laboratories which are under the direction of the National Board of Fire Underwriters.

Handy pocket edition of our catalogue and illustrated booklets mailed you upon request. UNIVERSAL PIPE is also featured in the A.S.M.E. Condensed Catalogues.

CENTRAL FOUNDRY COMPANY, 90 WEST STREET, NEW YORK
Sales Offices—New York, Chicago, Atlanta, Dallas, San Francisco

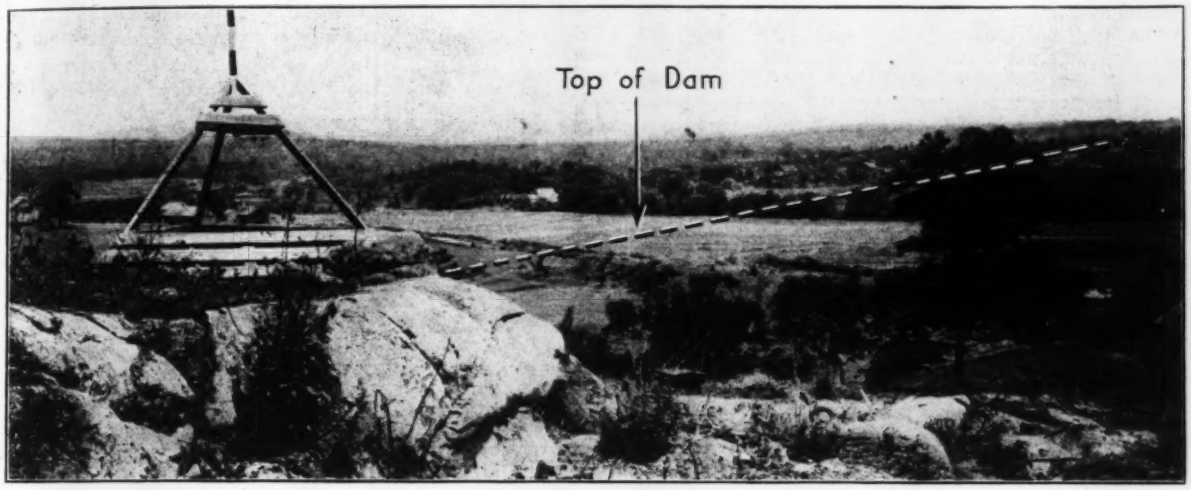
Engineering News-Record
A CONSOLIDATION OF ENGINEERING NEWS AND ENGINEERING RECORD
A Weekly Journal Devoted to Civil Engineering and Contracting
PUBLISHED BY MC GRAW-HILL PUBLISHING COMPANY, INC.

Volume 78 NEW YORK, THURSDAY, MAY 3, 1917 Number 5

New Water-Works at Providence, R. I., to Cost $12,000,000

Reservoir Will Be Formed by Earth Dam 100 Feet High—Three Types of Construction in Seven-Mile Aqueduct—First Contract Let

By FRANK E. WINSOR
Chief Engineer, Water-Supply Board, Providence, R. I.



THE MAIN DAM, 3200 FT. LONG, WILL BE OF EARTH, WITH CREST 100 FT. ABOVE GROUND SURFACE

THE main features of the new $12,000,000 system of water-supply for Providence, R. I., for which the first construction contract has recently been let, are an impounding reservoir in the town of Scituate, about 11 miles west of the city, an aqueduct about 7 miles in length connecting this reservoir with the present distribution system, a filtration plant and covered reservoirs for the storage of filtered water. In January, 1913, the City Council appointed a committee to take up the question of an increased water-supply, and preliminary engineering investigations were made under the direction of Samuel M. Gray, whose recommendations, after having been passed upon in March, 1915, by a consulting board consisting of Frederic P. Stearns, Allen Hazen, Albert S. Crane, W. P. Mason and W. H. Goodnough, were adopted, and the work was authorized by a special act of the General Assembly approved Apr. 21, 1915.

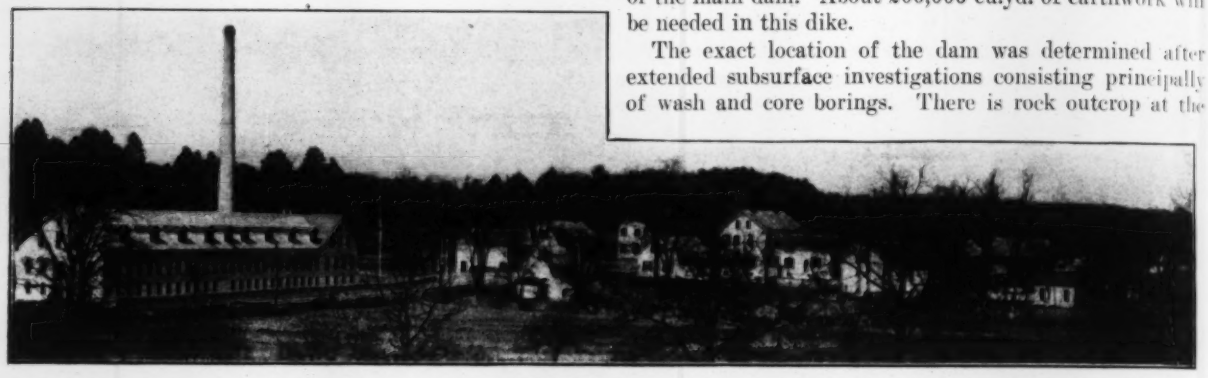
Present Water-Works Inadequate

The existing water-supply, from the Pawtuxet River, is filtered by ten 1-acre slow sand filters and serves a population of 300,000, of which 250,000 are in the City of Providence and 50,000 in adjacent towns. There is a drainage area tributary to the river above the present pumping station of 196 square miles. The river above the station is highly developed for power, there being eighteen large mills and mill villages below the village of Washington on the south branch and below the village of Hope on the north branch, all within a radius of about 8 miles of the station. The population of these villages is over 30,000, and the river is highly polluted by mill wastes and human dejecta, there being no adequate sewerage system. There have been no gagings of the natural flow past the pumping station and, owing to the development of this stream for power, no gagings are now practical. From a knowledge of other streams, however, the low flow is probably about 8 to 12 million gallons per day, or about one-half of the present water consumption. The additional water required by the city in times of low flow has been, and still is, obtained from water stored in reservoirs along the river, the total water stored amounting to approximately 5 billion gallons.

While the mills release this water for power when the stream flow is low, the needs of the mills and the city are by no means identical, and there is a possibility of the storage being exhausted before the end of a period of drought, in which case the city might be reduced to dependence upon the low flow of the stream. The deficiency of the stream flow is not infrequently such that on Sundays and holidays the pumps cannot be operated to their normal capacity, and the large distribution reservoirs of the city are drawn upon to maintain the supply until the flow of the river has been increased by the release of water by the mills for power.

The reservoir of the new water-works system will be formed by the construction of a large earth dam across the north branch of the Pawtuxet River at Kent, this location being about 12 miles above the present pumping station and above all the mill villages with the exception of those that have been acquired by the city in the reservoir basin. This reservoir will have a drainage area of about 92.8 square miles and a water surface of about 3600 acres. The total capacity of the reservoir will be about 37 billion gallons, and the elevation of the flow line 284 ft. above mean high water. Upon the basis of the rainfall records in the vicinity, together with a knowledge of the run-off of similar areas in Massachusetts and New York, it is believed that the reservoir will safely furnish a minimum quantity in periods of extreme drought of 85 million gallons per day, or more than four times the present average daily consumption.

The drainage area tributary to the new reservoir is sparsely populated. Although this area forms nearly 50%



THE SITE OF THE MILL AND DWELLINGS AT RICHMOND, R. I., WILL BE SUBMERGED UNDER 50 FT. OF WATER WHEN THE NEW RESERVOIR IS FILLED

of the area tributary to the river at the present pumping station, the population on this portion, exterior of the land under the control of the city, is only about 7% of that living on the area furnishing the present supply. The elevation of this reservoir will be such as to permit, after taking care of fluctuation in water level and head required for filtration, increasing the pressure by gravity throughout the portion of the city served at present by Sockanosset and Hope reservoirs by a maximum of about 25 lb. per sq.in. Pumping to portions, and perhaps all, of the present area served by the high service will be continued. After exhaustive studies of the conditions involved, it was decided that the new supply should be filtered and that the reservoir bottom should be thoroughly cleaned and shallow portions grubbed, but that no general stripping of the loam from the reservoir would be done.

Main Dam of Earth, 100 Feet High

The main dam of the Scituate reservoir will have a maximum height above the present surface of about 100 ft. and above bedrock of about 180 ft., the length being about 3200 ft. The details of the impervious diaphragm in this earth-fill have not yet been finally decided upon, but the approximate quantities of some of the principal items other than masonry are excavation 400,000 cu.yd., borrow 2,000,000 cu.yd., riprap 80,000 cu.yd. The spillway at the west end of the dam will be a masonry section about 450 ft. long, founded on rock, with a maximum height of about 15 ft. There will also be a reinforced-concrete highway arch bridge 200 ft. in length carrying the highway from the west end of the main dam across the arm of the reservoir leading to the spillway.

Diverting Works

Work is now in progress on construction of a concrete conduit and open channel for diverting the flow of the river by and through the dam during construction and later to form a part of the permanent stream control works; this is the first construction contract. This work was awarded Jan. 10, 1917, to the E. W. Foley Contracting Corporation. The approximate quantities of the principal items of this contract are earth excavation 65,000 cu.yd., rock excavation 9000 cu.yd., refilling and embankment 55,000 cu.yd., concrete masonry 8500 cu.yd. The completion of this work is required on Oct. 31, 1917.

An earth dike, generally very shallow, about 4000 ft. long is required, running easterly from the easterly end of the main dam. About 200,000 cu.yd. of earthwork will be needed in this dike.

The exact location of the dam was determined after extended subsurface investigations consisting principally of wash and core borings. There is rock outcrop at the westerly end of the dam and very little cover at the easterly end. For a length of about 1600 ft. the earth cover varies from 15 to 35 ft. in depth, for a length of about 500 ft. is from 35 to 50 ft. and for about 450 ft. is from 50 to 80 ft. in depth. The rock is all a gneissoid granite with no evidence of serious faults. The overlying material consists of coarse sand and gravel with pockets of fine sand and a considerable number of boulders.

Three Types of Aqueduct

The aqueduct may be divided into three general types of construction—tunnel, cut and cover (circular reinforced-concrete section), and cast iron or steel pipe—the lengths being respectively tunnel, 3.35 miles, cut and cover 1.68 miles, and cast iron or steel pipe 1.99 miles. The tunnel will be built with one construction shaft about 10,440 ft. from the west end, and from a very complete investigation by rock borings is believed to be all in rock.

The line of the tunnel first considered developed low rock surface in a portion of the line, about one-quarter way distant from the west portal. In order to avoid this condition the location was moved about 1000 ft. northerly at this point, making an angle in the line of the tunnel as the portal locations were not materially changed. Borings taken on the new line showed the rock surface to be enough higher to insure a substantial rock cover over the tunnel roof for its entire length.

The tunnel and cut-and-cover portions of the aqueduct, which not completely designed, will probably carry water at times under a head of about 20 ft. above the roof. The cut and cover will, it is expected, have a diameter of about 7½ ft. and the tunnel an equivalent area. The tunnel and cut and cover will be of sufficient size to carry the entire yield from the reservoir, but the pipe lines will be added to from time to time as the consumption increases.

Filtration Plant

The design of the filtration plant has not yet progressed sufficiently far to warrant its being described. This work, however, will be contracted for in time to permit its completion as soon as the new supply can be introduced into the city. It is expected that the new supply will not be exposed in open reservoirs, as at present, this practice having resulted in objectionable growths in the filtered water, but that such storage as is necessary for all normal conditions will be provided in covered reservoirs.

Highways

The construction of about 24 miles of highways, of which it is expected about 12 miles will be of bituminous macadam, is required. Two highway crossings of the reservoir are necessary, the larger of which, at Ashland, involves a fill of about 250,000 cu.yd. The other crosses the arm of the reservoir extending toward Ponaganset.

The tracks of the Providence & Danielson Ry., an electric line used for passenger and freight service, extend through the reservoir basin from North Scituate to Rockland for a distance of 7.67 miles, and will be relocated along the line of a new highway westerly of the reservoir, which, in order to accommodate this track, will be graded to a width of 50 ft. between slopes. The new track will be about 2¼ miles shorter than the present route. The abandonment of about 32 miles of highways will be caused by the construction of the reservoir.

Real Estate

The law provides for procuring land for the reservoir and protection from pollution, and a total area of about 13,000 acres has been obtained by condemnation and purchase. In addition to this, condemnation maps have been filed for all lands needed for aqueduct and highway construction. In the area condemned for the reservoir and for protection of the supply there are located six small mill villages, each of which owes its existence to water-power development. Three of these villages are inside the flow line of the proposed reservoir, two of the others being practically at the flow line. There are a total of about 1200 buildings inside the area taken, including the 6 cotton-mill plants referred to above, 1 power house and car barn, 414 dwellings, 7 school houses, 6 churches, 4 saw mills, 14 stores, 2 fire stations, 1 laundry, 1 police station, 11 icehouses, 5 blacksmith shops, etc. The boundary line of the main taking is 56.2 miles long. Two areas have been condemned for general burial grounds, to care for the removal of a considerable number of bodies buried largely in small farm cemeteries below or near the flow line.

First Contract Let

As stated above, work on the first construction contract is already in progress at the main dam. Preparation of plans, contracts and specifications for the major portions of the work is under way, and unless delayed by the present war and the high price of labor and materials, bids upon much of it will probably be invited during the year. Contract drawings and specifications for four highway contracts, three of which are essential in connection with the closing of roads in the vicinity of the main dam, are already prepared, providing for about 10 miles of new road construction. The advertising of this work has been temporarily delayed. Following these road contracts will be the main dam, which will probably be advertised as one contract, and the tunnel, which also will probably be advertised as one contract. Other contracts will follow in such order as to secure the completion of the work in the time required. It is expected that invitations for bids for all the work will be publicly advertised.

Water-Supply Statistics

Statistics relating to the present water-supply of Providence from 1906 to 1916 are given in the accompanying table.

The low per-capita consumption is undoubtedly due in a large degree to exceptionally efficient and careful management, coupled with the general use of meters. The high color of the water as furnished to the consumer is of interest. It should be noted that this color does not indicate by any means the peaks which occur not infrequently, and which run to very much higher figures. For example: In the summer of 1916, which is believed to be the period of highest color ever known, water drawn from a tap in the middle of the city showed a maximum color of 80 on Aug. 2 and 4 and above 60 for over three weeks.

PROVIDENCE WATER-SUPPLY STATISTICS 1906–1915

Year	Raw Water Bacteria per C.c. 48-Hour Count Max.	Raw Water Bacteria per C.c. 48-Hour Count Min.	Raw Water Bacteria per C.c. 48-Hour Count Av.	Filtered Water Standard Gelatine Max.	Filtered Water Standard Gelatine Min.	Filtered Water Standard Gelatine Av.	% Removed	Average Color Platinum Scale Raw Water	Average Color Platinum Scale Filtered Water	% Removed	Estimated Population Supplied	Average Daily per Capita, Gal.
1906	7,500	200	1,470	264	2	25	97.3			30	219,800	68
1907	8,000	120	1,030	271	1	16	98.0	54	35	35	225,700	72
1908	9,000	100	1,200	300	1	16	97.8	43	27	35	231,900	67
1909	12,000	150	1,930	1,500	1	31	97.5	46	30	35	237,200	64
1910	25,000	100	2,490	1,200	1	41	98.3	48	33	31	246,000	63
1911	8,000	100	1,350	200	1	13	98.6	48	33	30	254,100	65
1912	18,000	100	1,010	350	1	11	97.9	45	31	31	260,600	68
1913	10,000	100	1,500	150	1	10	98.4	46	32	30	267,000	66
1914	20,000	100	1,350	180	1	10	98.4	45	31	32	273,400	65
1915	6,000	100	1,200	70	1	8	98.7	49	33	33	278,700	62

The Water-Supply Board consists of B. Thomas Potter, chairman; William A. Schofield, Henry A. Grimwood, William P. Vaughn, John Kelso, Joseph H. Gainer, and Walter F. Slade, with Walter B. Chafee, secretary. The engineering work is under the direction of the writer as Chief Engineer with William W. Peabody, Deputy Chief Engineer. The work is divided into three divisions, William C. Pickersgill being in charge of the Designing Division, Frank E. Waterman in charge of the Reservoir Division and George T. Seabury in charge of the Dam and Aqueduct Division. Samuel M. Gray, Frederic P. Stearns and Allen Hazen are the consulting engineers.

Salt Test for Flow Works Well in Infiltration Gallery

Salt Injected at Upper End and Dilution Measured Below—Desirable Where Current Meter Cannot Be Used

BY APPLYING salt to the upper end of the infiltration galleries of the Des Moines Water Co., definite information was obtained as to the rate at which different portions of the line were yielding. The method and results were described recently by D. H. Maxwell, of Alvord & Burdick, Chicago, before the Illinois section of the American Water-Works Association, to show the utility of the chemical method even where its refinements and accuracy are not demanded, but because velocities are moderate or the channel is inaccessible.

The total length of gallery completed and in use at the time of the test was 8480 ft. Manholes are provided about 600 ft. apart. These galleries are built at a depth of from 20 to 25 ft. in the extensive and uniform coarse sand deposits and are submerged 5 to 10 ft. at low water. The newer part, 5160 ft. in length, is built of concrete rings and has a cross-section of 12.6 sq.ft. The older galleries are rectangular and vary from 15 to 20 sq.ft. in cross-section. When yielding at the rate of the present maximum pumpage, 14,000,000 gal. per day, the average velocity at the lower end of the main gallery is only 0.9 ft. per sec., the velocity decreasing progressively to practically zero at the far end.

In planning for future extensions, it was important to know the variations in yield between different parts of the gallery. Old measurements by current meter were not entirely satisfactory, because of the very low velocities in the gallery and the difficulty of determining the average velocity of the cross-section. It was decided to measure the flow by the chemical method as better adapted to the conditions.

How the Test Was Made

The test consisted in feeding at constant rate into one branch of the galleries near its upper end a solution containing a known amount of common salt, and titrating for chlorine in samples of the gallery water collected at all manholes between the dosing point and the pumping station, including a sample at the pumps just before the water entered the venturi meter. The chlorine determinations were expressed in parts per million. These determinations, corrected for normal chlorine, indicated the dilution, at any given point, of the salt fed into the gallery and gave a measure of the volume of flow at the corresponding point. The flow at any point is

$$Q = \frac{C - c_2}{c_2 - c_1} q$$

where Q is the desired gallery flow, q is the rate of dosing, C is concentration of salt solution, c_1 is normal concentration of chlorine in gallery water and c_2 is the concentration at the sampling point after dosing. The volume of the dose was so small that it was ignored except to keep it constant.

Having determined the rate of flow at each manhole, the difference between the flows at successive manholes gave the total infiltration rate of the gallery intervening; and this, divided by the length, gave the average yield per unit length. A check on the total yield of the galleries, computed by the salt method, was furnished by the venturi meter.

The solution was prepared by dissolving 57 lb. in about 35 gal. of water, as needed in each of the two barrels from which the solution was drawn alternately. Each barrel emptied in about 30 min. The barrels were piped into an orifice box, the water level in which operated a float valve controlling the barrel discharge. A $\frac{3}{16}$-in. orifice was provided under about a 4-ft. head, the idea in having a small orifice and a large head being to minimize the effect, on the discharge, of the slight fluctuations in head that were unavoidable with the float valve used. A 1-in. drop pipe with funnel at the upper end caught the solution below the orifice and delivered it to the center line of the gallery.

Difficulties Were Few

The dosing apparatus was not entirely satisfactory. Its principal defect was the imperfect arrangement for maintaining constant head on the orifice, and absolute uniformity of feeding could not be secured with it. Some trouble also was experienced with small splinters, in what appeared to be perfectly clean salt, becoming lodged across the orifice. This annoyance was overcome by straining the solution through cheesecloth as it entered the orifice box. The trouble with the feeding apparatus was the principal source of error in the work.

The dose was applied in the case of the main-gallery test at a point 600 ft. from the upper end, with satisfactory results. The average velocity at this point during the test was about 0.113 ft. per sec. In testing the shorter gallery the dose was applied only 350 ft. from the dead end, and the results seemed to indicate that the velocity at this point, about 0.03 ft. per sec., was too low for very satisfactory results. Diffusion of the salt interfered with appearance of constant chlorine concentration under constant draft on the gallery.

Samples were collected at intervals of about 1 hour throughout the test, in 200-c.c. bottles, which were lowered into the manholes and opened as nearly as possible at the gallery center line. This precaution was necessary, as at all the manholes there was considerable water standing in the shaft above the gallery; and this water doubtless lagged in chlorine content behind the main-gallery stream.

Results of the test indicate that the infiltration rate under constant draft on the galleries varied from 0.20 to 1.25 gal. per min. per foot of length of gallery. The low rates were found in the sections not adjacent to the river. The test was carried out in coöperation with Robert N. Kinnaird, superintendent, and E. T. Kirkpatrick, chemist, of the Des Moines Water Company.

Upkeep of a Ford

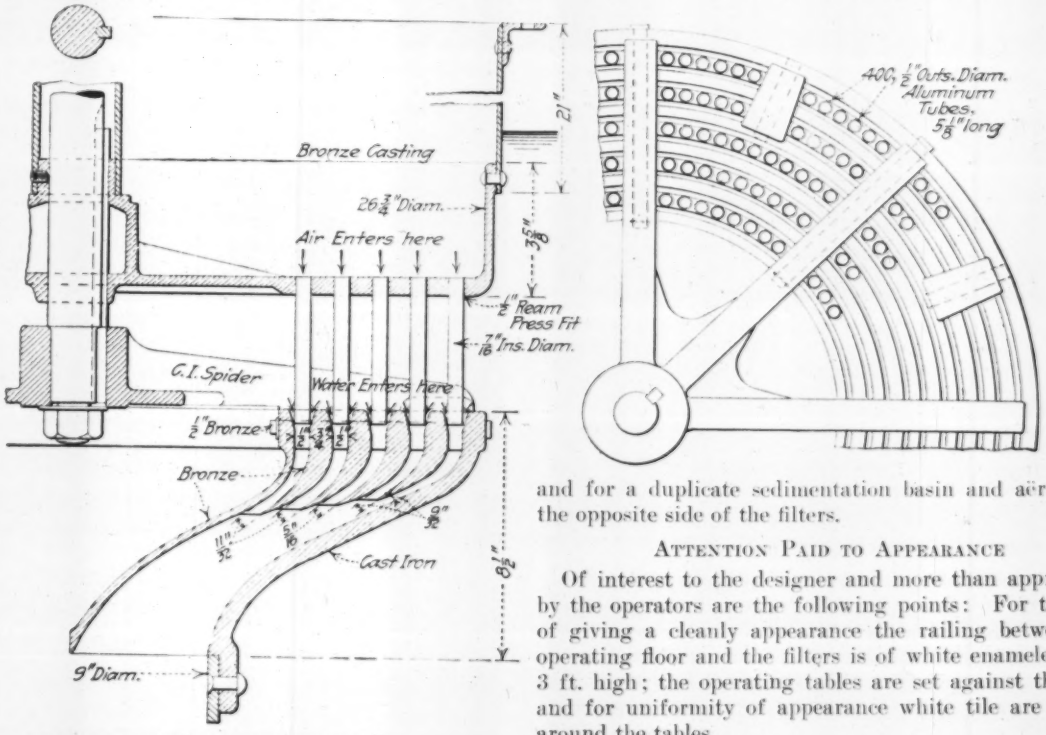
The third year's upkeep of a Ford car used by the Division of Sewage Disposal at Columbus, Ohio, is 5.3c. per mile, segregated as follows: Storage, 0.87c.; tires, 1.05c.; gasoline, 1.62c.; oil, 0.15c.; and miscellaneous, 1.61c. The car was driven 8255 miles, averaging 13.6 miles per gallon, although it varied from 8.4 miles in January and February to 15.6 miles in May and June. The total cost for the year was $438.

Multiple Inspirators Aërate Algae-Laden Lake Supply

Filter Plant Has Vortex-Whirl Sawdust and Sediment Remover, Also Combined Ridge-and-Valley and Plenum Underdrain System

ADAPTATION of a multiple-injector system will be used to aërate the algæ-laden water-supply for Oshkosh, Wis., when the 6,000,000-gal. filter plant, now nearing completion, has been put into service. There are four sets of four aërators each. Between the first and second aërators is a vortex-whirl apparatus to separate the air and light material, such as sawdust, from the top, and heavy sediment from the bottom. Other departures are the use of a combined ridge-and-valley and plenum underdrain system, and a positive-feed chemical-feed proportioner.

Oshkosh gets its water from Winnebago Lake, a comparatively shallow body of water infested with algæ, particularly during the summer months. The sewage of the city empties into the lake at two points nearly a mile distant.



AËRATOR WORKS ON PRINCIPLE OF MULTIPLE INSPIRATORS

Improvements started in 1916 consist of a new intake 1225 ft. from shore in 13 ft. of water, a concrete cover over an existing 1,500,000-gal. reinforced-concrete reservoir, six filter units of 1,000,000-gal. capacity each, a 600,000-gal. sedimentation basin and a low-lift pumping equipment to raise the water from the lake level 19 ft. to the sedimentation basin. A monumental brick-incased tower with a triple purpose rises in the center of the structures. It serves to house an elevated steel wash-water tank of 50,000-gal. capacity, and also as a chimney and as a ventilating shaft to remove the odors from the aërators and vortex whirls. The chimney will not be used at present, for the existing pumping station will continue to do duty as high-service pumps and the two "Roturbo" 4,000,000-gal. centrifugal pumps will be electrically driven.

In general layout the filter plant differs but little from the usual type with an extra-wide pipe gallery between two banks of filter tanks, under which is the clear-water basin and over which is a two-story brick structure providing laboratory and chemical-storage space on the second floor. The sedimentation basin is at one side, with the narrow aërator house on top of it. Provision is made for future filters at the end of the present bank of filters, and for a duplicate sedimentation basin and aërator on the opposite side of the filters.

Attention Paid to Appearance

Of interest to the designer and more than appreciated by the operators are the following points: For the sake of giving a cleanly appearance the railing between the operating floor and the filters is of white enameled brick 3 ft. high; the operating tables are set against this rail, and for uniformity of appearance white tile are carried around the tables.

Walks are provided on top of the walls dividing the filters and across the back end of the filters, for the purpose of inspection and also to get at the windows. These walks have a small sanitary curb to prevent dirty water from washing into the filters. Radiators for heating this room are hung on the back of the railing, so as to bring the heat as close to the operating floor as possible.

The raw-water chamber in which the aërators are located is lined with white tile, so that the condition may be observed at all times. In the pipe gallery the conduits are all of cast iron with bell-and-spigot joints, except on the wash-water lines, which are of wrought iron with flanged joints. The wash-water drain is laid on the bottom with a concrete walkway above it on piers, sufficient clearance being given for unobstructed passage

Entering from the pipe gallery, the raw water passes first into a chamber in which are four aërators, each proportioned to handle 1,000,000 gal. per day. The construction of the aërators provides a simple means of adjusting the air pipes in the annular suction rings and also of adjusting the total height to from 8 to 12½ ft., through which the water will pass to the outlets below into the side of the vortex whirls. The pipes are screwed into the bottom of a bowl-shaped float, and the separate rings making the annular suction passages are secured to a supporting spider by a rod. The air at the bottom will be under 4-lb. pressure, and it is estimated that 1 cu.ft. of air will be drawn in for each cubic foot of water.

Leaving the aërator, the water will pass into the side of the vortex whirl, being given a rotary and slight downward movement by a thin baffle plate so as to start sedimentation of the heavier particles. The water will be in this device about 40 sec. A sludge chamber at the bottom for the heavier solids, which settle, has a water jet to be operated occasionally to flush out material into the drain. Floating material is drawn from the top through six openings 1 in. deep and 1¼ in. wide in the sides of an open-topped float. The float is supported

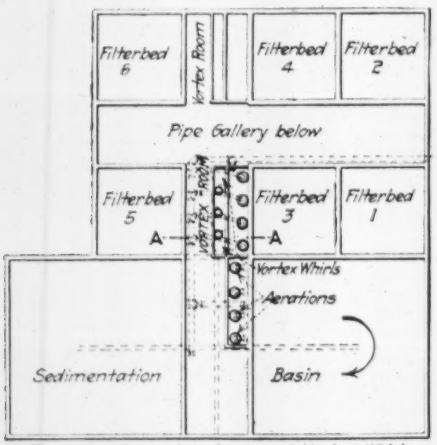
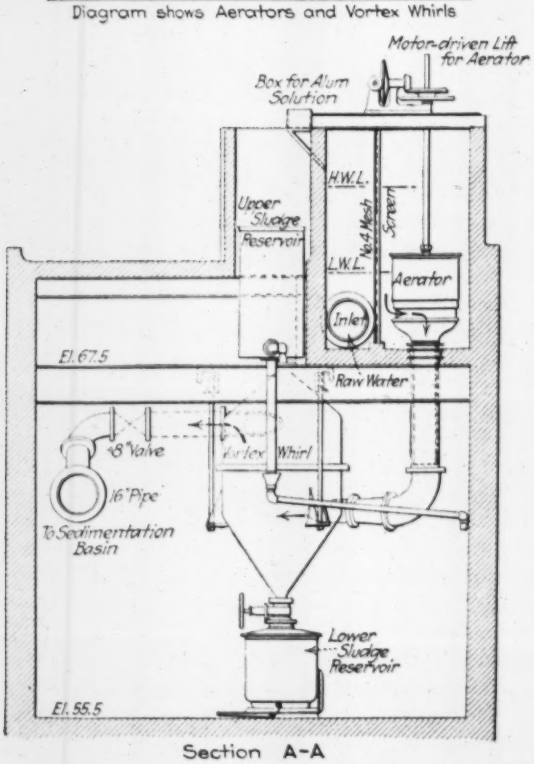
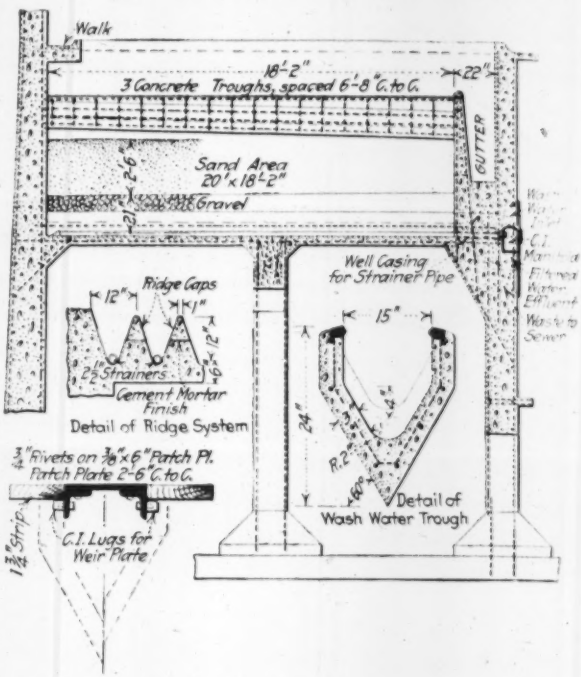


Diagram shows Aerators and Vortex Whirls



Section A-A

FOUR VORTEX WHIRLS AND AERATORS MAKE UP THE FIRST BATTERY



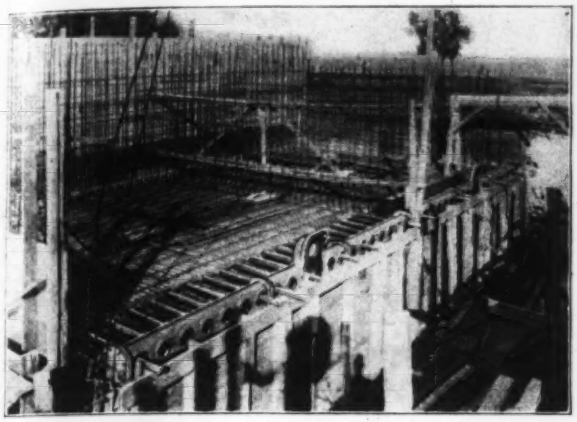
STRAINER PIPES ARE INSERTED THROUGH MANIFOLD AND WELL CASING EMBEDDED IN WALL

1½-in. central brass pipe sliding in a graphite bronze bushing 10 in. long leading to the drain. The water leaving the vortex may go direct to the sedimentation basin or to a second set of aërators which discharges into the bottom of the basin against a concrete block cutwater, deflecting the water outward and upward behind a slotted baffle consisting of 2-in. planks separated by 1-in. spacers. The second set of aërators provides a height sufficient to produce a pressure of 6 lb. per square inch.

The two sedimentation basins each have a longitudinal around-the-end baffle and four valves in the wall, separating them so that the water can be let through either near the top or near the bottom. This provision is made with the idea of breaking up any tendency to short-circuit or stagnate. Based on the total capacity and cross-section, the water will be in the basins about 2 hours and move normally at the rate of 2 ft. per minute.

Underdrains Have Manifold in Gallery

At the bottom of the regulation type of ridge-and-valley construction forming the reinforced-concrete floor of the filter, perforated pipes are placed having an opening equivalent to 0.23% of the filter area. One row of ½-in. holes is drilled on the bottom at varying distances apart, 1½ to 1⅞ in., closer at the end nearest the outlet, on account of the smaller head due to the greater velocity head. Two other rows of ⅛-in. holes are drilled on equal spacing of 1½ in. on the horizontal axis of the pipe, but none are drilled in the top so as to avoid any direct jet action on the gravel. No screens are used, reliance



THE UNDERDRAIN MANIFOLD IS BUILT INTO PIPE-GALLERY WALL OF FILTER

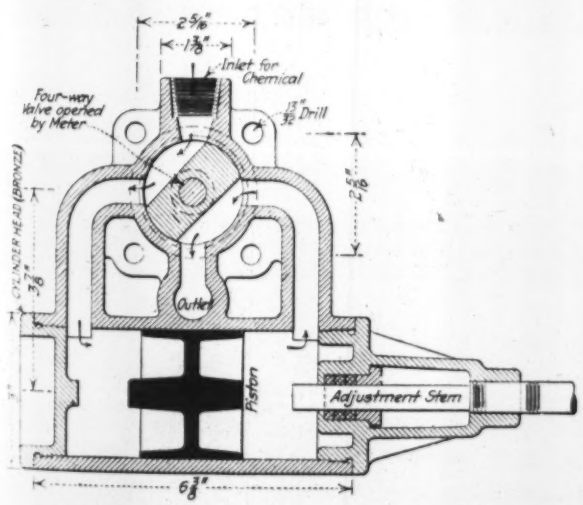
for support of the 30-in. layer of sand being placed on the 21-in. layer of graded gravel.

Another novel feature of the underdrains is the use of a manifold set in the end of the filter with wrought-iron pipes screwed into it to serve as forms through the concrete filter wall for the insertion later of the strainer or perforated pipes. The latter are inserted from the pipe gallery through handholes in the back side of the manifold, thus permitting a removal of any obstruction in the pipe without tearing out the whole filter bed. The filter gallery has been kept clear of obstruction so that the pipes may also be removed, should it be found necessary at some future date. The manifold has a connection for air, but it is not intended to use air unless experience proves the 2-ft. vertical rise of wash water provided does not furnish sufficient agitation.

The concrete wash-water troughs were poured upside down with the small castings to hold the bronze weir edges bolted to angles, thus giving a good face to the concrete behind the weir plate.

Proportional Chemical Feeder Positive

Chemicals are to be added at different points, depending upon operating experience; but the control is effected through the operation of a proportional feeder actuated by the counter driving stem of a Kreutzberg meter placed between the second set of aërators and the vortex whirls. The rotation of a fourway valve connected to the chemical supply pushes a rubber piston back and forth, delivering to the outlet an amount equal, not to the time the fourway valve is open, but to the volume ahead of the piston. In consequence one revolution of the meter, which is proportioned to the flow, always ejects the same volume of chemical into the supply. To vary the amount discharged at each revolution, an adjustment stem with a calibrated hand nut shortens or lengthens the stroke of the piston.



CHEMICAL FEED IS PROPORTIONED TO FLOW OF SUPPLY

Col. Henry A. Allen, consulting engineer, Chicago, drew up the plans for the filter plant and other improvements of the Oshkosh water-works system. His representative on the ground was T. B. Jorgensen.

Patents on a number of the devices described have been granted to Colonel Allen, among which are the chemical proportioner, the underdrain manifold, the aërator and the vortex-whirl apparatus.

The filtration structures and buildings were built by the Larson Construction Co., and the steel tower was erected by the Waupaca Iron Works. The Roberts Filter Manufacturing Co. put in the filter appliances.

Garbage Collection by Motor Truck in Los Angeles

The City of Los Angeles collects its garbage without cost to the residents, the department being maintained by general taxation. Garbage is delivered under contract to the Pacific Reduction Co., a $1,000,000 corporation organized to operate a disposal plant for handling garbage and other refuse produced by the city. The contract stipulates that the company pay the city 51c. per ton for all garbage delivered to the reduction works.

The city is divided into two zones, in one of which garbage is collected by teams and in the other by motor trucks. For the latter the full-load haul ranges from six to nine miles, averaging approximately eight miles. In this zone a total of about 300 tons of garbage is collected each month by two 2½-ton motor trucks at a cost of $2.76 per ton. Noncombustibles in both districts are collected by seven 2½-ton trucks that bring in a total of about 3300 cu.yd. of rubbish per month at a cost of 94c. per cubic yard.

The short-haul zone is served by teams using both day and night shifts. The night shift has a monthly average of 2800 tons at a cost of about $1.18 per ton. The day shift averages about 2200 tons per month at a cost of $2.15 per ton.

The cost of operating the trucks ranges from $210 to $250 per month. This includes fuel, driver, lubricants, repairs and depreciation, but is exclusive of the two garbage collectors who accompany each truck. The trucks average two or more loads per day and haul an average of 2¾ tons per load. Before trucks were adopted, these collections were made by three-horse teams, each of which made a single round trip each day. The use of motor trucks for the outlying districts has proved so satisfactory that the city would not consider a return to the use of teams for this zone.

New Reservoir and Water Mains Improve Service at Covington, Va.

Old Basin Superseded by Concrete-Lined Structure—Distribution System of Small Pipes Strengthened

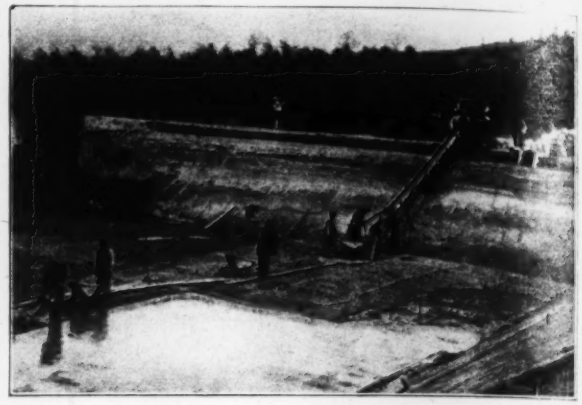
By HARRY STEVENS
Consulting Engineer, Washington, D. C.

A WATER-WORKS rejuvenation has been completed at Covington, Va., since the town of 6000 inhabitants installed a new reservoir for its spring-water supply and strengthened its distribution system, of 1-, 2- and 3-in. pipes, by mains of larger sizes. The old reservoir was in the bottom of a small hollow, receiving the surface drainage from the adjoining cow pastures. Surrounded by marshes and frog-ponds, together with a high board fence, it was about as uninviting a place to store a public supply of water as could have been selected. It consisted merely of a basin scooped out of the earth, with an earthen dam at the lower end, the inside being partly paved with loose stones. Its capacity probably did not exceed 100,000 gal., a reserve entirely inadequate during the dry season, when raw water had to be pumped from the Jackson River to make up the deficiency.

Distribution System Defective

In about the same condition of obsolescence was the distribution system of the town. The pipes, with the exception of one 10-in. main and a few short mains of 4-, 6- and 8-in. pipe, were entirely too small, about half of them being constructed of 3- and 4-in. cast-iron pipe and the balance of 1-, 1½- and 2-in. wrought-iron pipe. Bath St., the main business street of the town, was served by a 4-in. pipe, and a main cross-street for a distance of 3300 ft. was provided with only a 3-in. main fed from each end. One street had over 1200 ft. of 1-in. main fed from one end. One 6-in. main, connected to the 10-in. main by means of one 3-in. and one 4-in. main laid along different routes, furnished the only connection between the reservoir and the distribution system and source of supply. Complaints of insufficient pressure were numerous, and the question of building a new reservoir at an elevation of from 75 to 100 ft. above the old one was agitated, although the old reservoir was already located about 200 ft. above the main portion of the town.

Water is obtained from a spring located about 4 miles distant from the town and at an elevation of between 300 and 400 ft. above same. The water is conveyed through a 12-in. and 10-in. cast-iron pipe line by gravity to the southern end of the town, where it is discharged directly into the distribution system. When the flow of the spring exceeds the amount being used, the surplus water passes into the reservoir which is located on a hill at the northern end of the town; and when the demand exceeds the supply, the water stored in this reservoir makes up the deficiency.

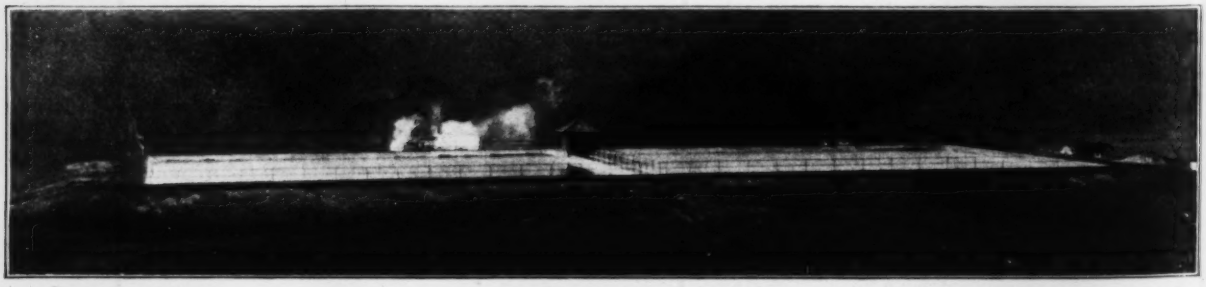


FLOOR CONCRETE WAS DELIVERED BY CHUTE FEEDING INTO WHEELBARROWS

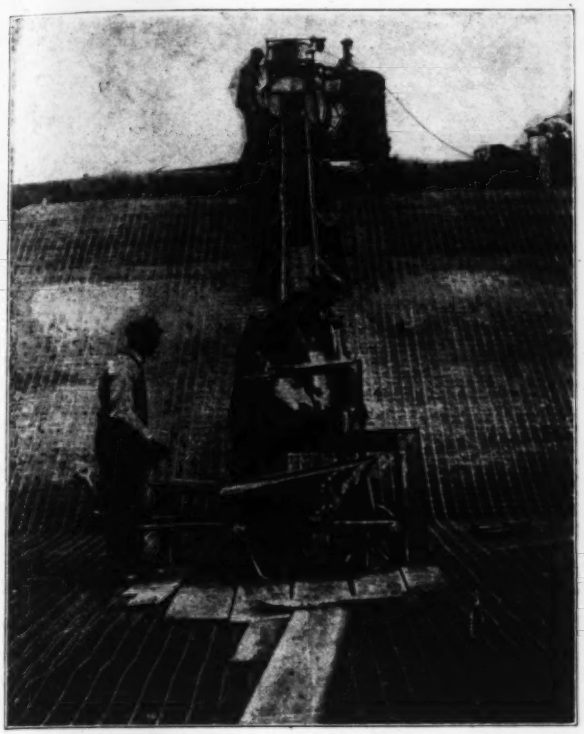
After the citizens had voted down a proposition to construct a filter plant and pumping station for the purpose of obtaining an additional supply from the Jackson River, it was decided to construct a new reservoir at a slightly higher elevation than the old one and to lay a 10-in. main from it to connect with the 10-in. main in town. This would make a direct 10-in. connection between the spring and the reservoir and would provide a sort of backbone, through the center of the town, for a better distribution system. It was also decided to lay 8-in. mains to replace existing 3-in. and 4-in. mains on the principal streets.

New Concrete Reservoir

Plans were prepared for a reservoir holding somewhat over 2,000,000 gal., and a site was selected on a knoll near the old one at a point where the ground sloped away in every direction. The new reservoir, with a high-water elevation about 16 ft. above that of the old, consists of two concrete-lined basins, each having a capacity a little over 1,000,000 gal. and both connected to a central valve-house. The 10-in. main from the spring and town leads directly into the chamber underneath this valvehouse, the water in the chamber standing at the same level as the water in the basin being used. A vertical overflow pipe inside the valve chamber serves both basins, the



THE NEW RESERVOIR CONSISTS OF TWO CONCRETE-LINED BASINS, EACH WITH A CAPACITY OF 1,000,000 GAL.



THE MIXER ON TOP OF THE EMBANKMENT WAS MOVED AS WORK PROGRESSED

overflow and both drain pipes being connected through a side-outlet tee to a 10-in. waste pipe that discharges into the overflow of the old reservoir. The inlet pipe of each basin is carried along the bottom to the corner diagonally opposite the outlets, for the purpose of creating a circulation, the check valves on the inlet and outlet pipes in the valve chamber controlling the direction of flow.

With this arrangement and a proper manipulation of the valves, either or both basins may be used at the same time; one basin may be in use while the other is empty or being drained, or both may be cut out and the same head be maintained on the distribution system, assuming in that case that the spring is supplying more water than is being used. The water may also be drawn from the bottom or top of either basin, and the valve chamber may be drained for inspection or repairs by closing the valves on the outlet pipes from both basins, and on the pipe to the town, and opening the 3-in. gate valve connected with the side-outlet tee on the waste pipe.

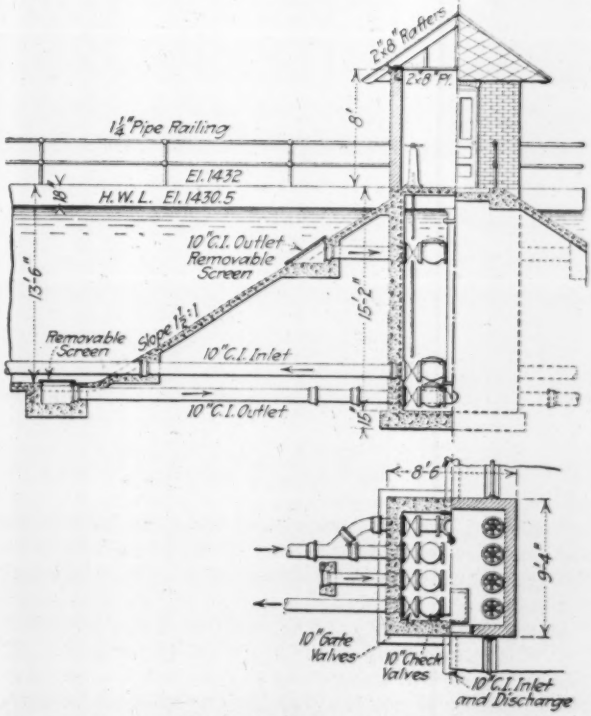
In constructing the reservoir the site was first stripped of all sod, loam, etc., and the excavation carried on by means of plows and drag scrapers. The soil was a hard clay mixed with gravel and round stones up to the size of a man's head, and a hardpan plow had to be used to loosen it. The embankments were formed of the excavated material, deposited by the scrapers in 8-in. layers and thoroughly rolled with a horse-drawn roller weighing about 200 lb. per lin.in. When the excavated material was exceptionally dry, it was moistened slightly by sprinkling before being rolled, but as a general rule the earth was sufficiently moist to allow it to become highly compacted under the rolling. The embankments were made larger than called for by the plans and then dressed to the required size by hand. The last 9 in. of excavation on both sides and bottom was also removed by hand. The concrete portion of the valvehouse was constructed, and all underground pipes were installed before beginning work on the reservoir.

How Concrete Lining Was Placed

The entire interior of each basin was faced with a concrete lining consisting of a 6-in. base mixed in the proportions 1:2:4, and a ½-in. top coat of 1:2 cement mortar was applied before the base had set. The base was reinforced with wire cloth made of No. 10 wires spaced 4 in. center to center. Both base and topcoat were mixed in a one-bag batch gasoline mixer mounted on wheels. The mixer was used on top of the embankment, being moved from place to place as required, and the concrete was discharged through a chute to the work below.

The wire-cloth reinforcing was furnished in rolls about 8 ft. wide and was used in continuous strips from the upper edge of one side to the upper edge of the one opposite. The longitudinal joints were lapped 8 in. and the crossjoints 12 in. both being wired together at intervals. At first the reinforcing was supported on brickbats of the proper height and the concrete placed over it, leaving the bats in place; but this plan did not work well, and it was found that a much better job could be done by leaving the reinforcing on the ground until after the concrete was placed and then pulling it up to the proper position before the ramming was commenced.

In placing the lining in the first basin the bottom was first completed and then the sides up to a point as high as a man could reach. The remainder of the sides was in-



THE VALVE ARRANGEMENT ALLOWS EITHER OR BOTH BASINS TO BE USED

stalled after the upper edge of the lower part had set sufficiently to hold the workmen. This procedure left a rather unsightly joint, and in lining the second basin the bottom was first completed and the sides then laid in one piece from bottom to top, the concrete being worked in vertical strips about 3 ft. wide from a long ladder laid on the slope and moved ahead as each strip was completed. In this way a much better looking job resulted, and it took less time than by the first method. In both cases the top lip, or curb, holding the railing was built after the rest of the lining was in place.

The contract for constructing the reservoir complete was awarded to Beardsley, Dougan & Beardsley, of Roanoke, Va., the contract price being $12,020.69. All the work of laying the new water mains, including the trenching and backfilling, was done by the town's own force of workmen, the total cost of this part amounting to about $13,000. The plans and specifications were prepared by the writer, and the work was constructed under his supervision.

Hetch Hetchy Reservoir Site Is Being Cleared

On First 808 Acres Costs Totaled $61.88 per Acre, of Which $56.50 Is Recoverable in Value of Wood

WORK is now actively under way in clearing the 2000 acres of land that will be flooded when the Hetch Hetchy reservoir is built in the system which is to provide a new water-supply for San Francisco. Thus far the clearing has been done chiefly by contract, and the cost has been affected by difficulty with contractors and the necessity for taking over uncompleted work. Another point is that the cost of transporting materials to the site is high, as the work is 58 miles from the railroad. Transportation costs amounted to about 45c. per ton-mile, or $22.50 per ton between railroad and reservoir. Common labor on the work cost $3 per eight hours.

Logs Cut to 16-Foot Lengths

The specifications required that all standing trees, brush and shrubs be cut down and used for sawlogs or cordwood, or be burned. Oak, cottonwood, alder, maple and willow were cut and piled as cordwood at a price of $2.95 per cord. All soft woods, including cedar, yellow pine, sugar pine and red fir, which were over 6 in. in diameter at the butt and which were considered suitable for sawlogs by the city's engineers, were cut into 16-ft. lengths or longer, peeled and left piled on cedar skids at a cost of $2.20 per 100 ft. b.m. When the reservoir is full, it is the plan to float logs so piled to the dam, where they will be sawed into lumber.

Soft wood less than 6 in. in diameter at the butt, or for any cause not suitable for sawlogs, is cut into cordwood in the same manner as the hardwoods, at a price of $2.45 per cord.

On the first of January 808 acres had been cleared at a cost of approximately $50,000, or $61.88 per acre. Of this total a certain amount can be deducted for the value of cordwood and sawlogs that the city now has in marketable shape. Allowing for the cordwood at an average price of $3.50 per cord, the value of the cordwood per acre is about $50. Taking the average value of the sawlogs at $5 per 1000 ft., the average value of this class of wood per acre is about $6.50. Thus the total recoverable to be deducted from clearing cost per acre is about $56.50.

CLEARING HETCH HETCHY RESERVOIR SITE

The contract specified that payment should be only for cordage actually turned over to the city authorities at the time that the job was approved and accepted. About 2% of the total amount of wood corded up was destroyed by fire before the contract was finished, so that this amount of loss was suffered by the contractor, and the city's recoverable value was correspondingly decreased.

Night-Rate Consumption Barometer in 100% Metered City

Fine-Tooth-Comb Method of Hunting Leaks Includes Feeding Isolated Districts Through Fire Hose and Small Meter

FLUCTUATIONS of the night-rate curve of water consumption in Oak Park, Ill., a 100% metered city, is considered the consumption barometer. The maximum allowable night rate according to the standard set is 20% of the average daily consumption. Although no water is intentionally delivered free of charge or without accurate measuring devices, the fact remains that only constant vigilance keeps the waste at a minimum. The rate of flow between midnight and 5 a.m. is to a great extent a measure of waste. Some of it is accounted for by meters in the form of fixture leakage, and many industrial plants operate all night; but as stated above, the fluctuation of the night-rate curve is a barometer to be watched daily.

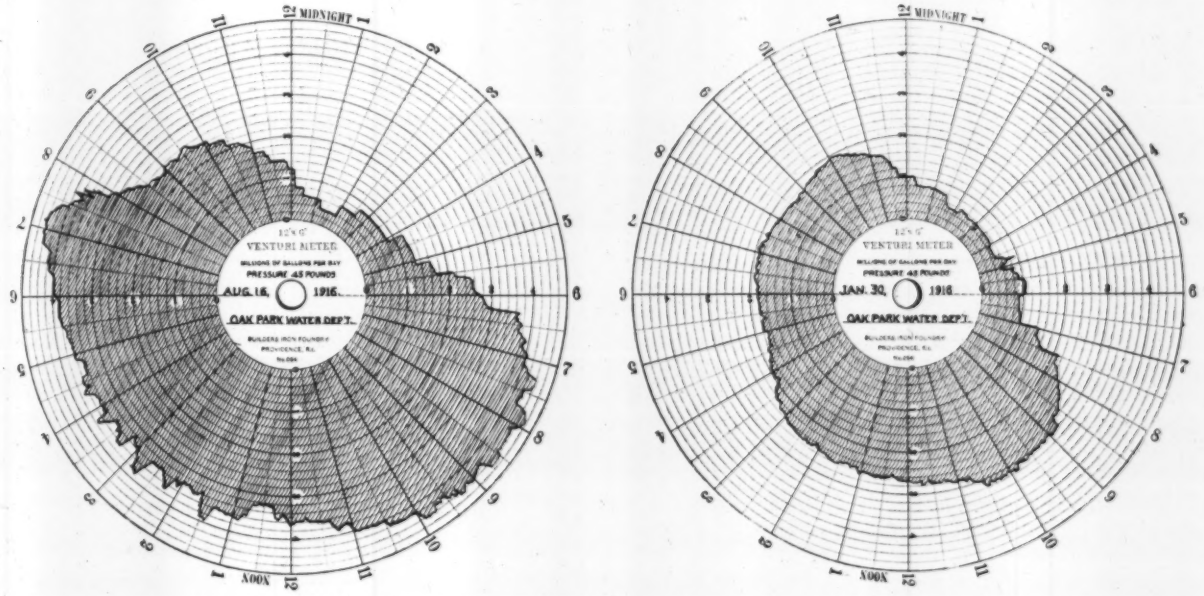
Vigilance the Price

At the present time 20% of the consumption means 900 gal. daily per inch-mile of pipe, equivalent to 460,000 gal. daily for the system. During 1915 the night rate was reduced from 40.2 to 29.5% by the rigid inspection of fire hydrants and services, by a waste campaign and by testing and repairing all meters that had been in service for five years without attention.

Last summer a gradual increase to the million mark (43.4% of the daily rate) was experienced in spite of inspections. Automatic lawn sprinklers used night and day were the cause, and it was proved by the reduction to

900,000 gal. in the fall and by the enormous water bills rendered to domestic consumers. The fall inspection of hydrants and the repair of leaky services further reduced the night rate to 700,000 gal. daily, equivalent to 31.8% of the average consumption. However, with the advent of winter the night rate again climbed to 800,000 gal., due to leaving faucets open to prevent freezing. By March the night rate had reached 1,000,000 gal., and the meter readers and inspectors were bringing in daily reports of leaking services that did not show on the surface of the street, but were detected by sound on the pipes at the meters. Repair of these leaks was rewarded by a reduction to 37%.

It was then decided to make an annual water-waste survey early in 1917, which has resulted in the discovery of unoccupied improvement stubs delivering the excess water into the sewers. The frost penetrated unusually deep and had made short work of many of these 3500 connections. This work is accomplished with difficulty, because the leaking stubs are nearly all under asphaltic-concrete pavements.



TYPICAL VENTURI RECORDS INDICATE SHORT MINIMUM-RATE PERIOD FOR SUMMER

Feed Cutoff Districts Through Fire Hose

Unnecessary holes, however, are rarely made because of the methods of detection employed. At first, in 1914, the pitometer was used in making the survey, but the waste was reduced to such an extent that the consequent low velocity did not permit the taking of reliable measurements. As small a flow as 3 gal. per min., the amount of a single smallest service leak, had to be detected. Then isolated districts—sometimes only a block, but more often ¼ to ½ mile long—were fed by fire hose connecting hydrants without and within the district, 400 ft. of hose being the average length necessary. The flow was measured with a ¾-in. or 1-in. disk meter. Finally, the need of obtaining the rate more accurately and without a large number of observations led to the use of a 2-in. venturi with a ⅝-in. throat, providing a range of from 3 to 35 gal. per min. In fact, smaller quantities could be detected. Pressure gages were placed at each end of the hose to enable the operators to compute the flow at normal pressures.

By the following process much of the detail work of locating every service and testing it with an aquaphone placed on the service cock was eliminated. An analysis of the previous water bills from the meter-reading cards or ledger sheets furnished the clue for possible fixture leakage. The suspected places only were inspected and shut off for the test, if important, thus avoiding a house-to-house canvass for interior leakage. If the minimum daily rate in a district did not exceed the assumed limit of 1000 gal. per inch-mile of main, it was considered in a good condition for the present and the record was filed for future use.

As a result of these fine-tooth-comb methods the present night rate is the same for the entire system as it was in 1913. Although the average daily consumption has risen from 1,800,000 gal. to 2,300,000 gal., the percentage of night rate to the average daily consumption has dropped from 44.4 to 34.7, and the present survey is expected to bring it down to the standard 20%. While the per capita consumption rate in 1916 was 5 gal. per day greater, 70.6 gal., than during the previous year, it is definitely known from the night curve that the waste or leakage has decreased. Of the total annual consumption, 82% passed through meters and was paid for.

Another point learned is that the consumption rate varies definitely with the pressure. If the night rate is 900,000 gal. at 45 lb., it will be 800,000 gal. at 40 lb. and 1,000,000 gal. at 50 lb. As Oak Park buys water from Chicago at the regular domestic rates, 100,000 gal. daily means $2500 a year, so a normal static pressure of 45 lb. at the fire hydrants is maintained as nearly as possible. This is increased to 70 lb. for fire pressure.

Water-waste prevention is part of the duties of the engineer of the Water-Works Department, H. P. T. Matte, reporting to W. F. Sargent, commissioner of public works.

Concrete Consistency Measured by Simple Field Test

Wet, Mushy, Sloppy or Soupy Concrete Quantitatively Determined by "Heap Test," Using Angle of Repose

By HAROLD A. THOMAS

Associate Professor of Civil Engineering, Rose Polytechnic Institute, Terre Haute, Ind.

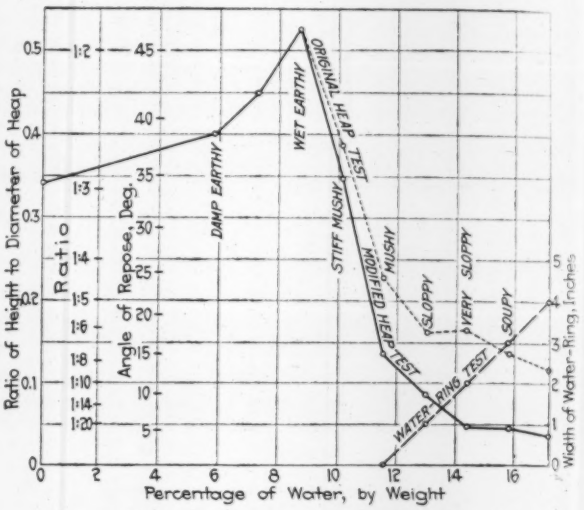
IT HAS been frequently pointed out that concrete mixed to an improper consistency is apt to be lacking in strength and uniformity, but that the correct proportion of water to use varies greatly with the fineness, porosity and wetness of the aggregates and the amount and kind of cement. An editorial in *Engineering News*, Feb. 22, 1917, called attention to the need for a quantitative method for measuring the consistency of concrete, so that this quantity might be specified more accurately than by the usual descriptive terms such as "sloppy" or "mushy." It occurred to the writer that such a quantitative measure would be furnished by the "angle of repose," or steepest surface slope that can exist on an unconfined mass of freshly mixed concrete, as it is evident that in general this slope becomes flatter as the consistency becomes wetter. With this in mind a number of experiments were made at Rose Polytechnic Institute to see if a simple, certain and practical method could be found for measuring the angle of repose of a sample of freshly mixed concrete. The "heap test" specification described in the following paragraphs is the result of these experiments.

Preliminary Experimentation

The method first tested was to fill with concrete a vessel, such as a bucket or wheelbarrow, and tip it until the concrete assumed its maximum surface slope, measuring the inclination with a carpenters' level and rule. It was found that, while this method gave slopes varying with the consistency, the surface of the concrete was in many cases so far from being plane as to make the method unreliable for practical use.

The next test devised gave more satisfactory results. In making this test, a sample of the concrete to be tested was placed in a pail and poured out in a heap on a level impervious surface, the height and diameter of the heap giving the data for determining the angle of repose. The pouring was done slowly and with as little free fall as possible. The results obtained by this test on concretes of different consistencies are shown by the dotted line in the accompanying diagram. As may be seen from this curve, the test gives a sensitive measure of the consistency of medium and mushy concretes. It is, however, not so well adapted to distinguishing between sloppy concretes, the reason being that in wet concretes the fine materials separate from the coarse aggregate and spread out, leaving the coarse aggregate in the center in a clean pile with steep slopes. The ratio of the height to the diameter of the entire heap, which measures half the tangent of the angle of repose, therefore changes but slowly after the concrete becomes so wet that there is considerable separation of the aggregates.

After some experimenting it was found that the heap test would give more sensitive results in the case of sloppy concrete, when modified as follows: A pailful of the freshly mixed concrete was slowly poured out in a heap on a level impervious surface as before, but instead of emptying the pail, the pouring was stopped as soon as the concrete began to pile up so that the slope near the center of the heap was steeper than near the edge. In the case of mushy concrete this occurred when the pail was about three-fourths empty, and in the case of very sloppy concrete when the pail was about one-fourth empty. The solid line in the diagram shows results obtained by this test. It is seen to be more accurate than the preceding test in differentiating between sloppy consistencies, there being 300% variation in the ratio of the height to the diameter of the heap, between the mushy and very sloppy concretes experimented upon. It was found that the results of this test were not affected by considerable variations in the speed of pouring or quantity of concrete used.



RESULTS OBTAINED BY THE "HEAP TEST" FOR THE CONSISTENCY OF CONCRETE

Description of Consistencies:

"Damp earthy"—Water will not flush to the surface after prolonged tamping

"Wet earthy"—Ordinary dry concrete. Water flushes to surface with moderate tamping. Quakes slightly

"Stiff mushy"—Water flushes freely to surface with slight tamping. Mixture quakes considerably

"Mushy"—Medium consistency, wet muddy appearance. Quakes freely. Flows easily down chute at 34°. Tamping not required

"Sloppy"—Excess water separates easily. Hard to keep aggregates together. Flows readily down chute at 17°

"Very sloppy"—Impossible to keep water and aggregates together when not in motion. Flows down chute at 13°

"Soupy"—Large excess of cement-laden water will not combine with aggregates

Soupy Concrete Gave Trouble

In the cases of concrete of "soupy" consistency, even the method just described failed to give a good quantitative distinction between different degrees of wetness, as may be noted from the diagram. In working with samples of concrete of this kind an additional peculiarity of the heap test was observed, which not only affords this distinction, but appears to give a practical measure for a property of considerable importance in wet concretes—the segregation of the cement and aggregates. The very wet concretes experimented upon showed so strong a tendency toward segregation that the heaps consisted of three distinct zones: An inner pile of clean coarse aggregate with steep slopes, an intermediate zone of fine ag-

gregate with moderate slopes, and an outer ring or pool of cement-laden water. When this separation occurred to a considerable extent, the ratio of the height to the diameter of the heap changed but little with increasing wetness. The width of the ring of separated water was found to increase rapidly with the general wetness of the concrete, as is indicated by the dash line in the diagram. It was quite constant for samples of a given consistency, but increased slightly with time, one minute after pouring being taken as standard. The measurement of the average width of the ring of cement-laden water surrounding the aggregates in the heap test may therefore be used as an additional quantitative criterion for the consistency of wet concretes. It also gives a numerical indication of the tendency toward separation of the ingredients.

To see if a more precise method could be obtained for measuring the tendency toward segregation, a number of tests were made by placing the wet concrete samples in various kinds of screens and strainers and measuring the percentage of water and fine material separating. These methods were found to give less uniform results than those obtained by measurement of the width of the ring of separated water in the heap test.

Somewhat Similar to an Earlier Test

The heap test is not well adapted to specifying the consistencies of very dry concretes. As shown by the diagram, in the case of dry concretes the height of the heap increases instead of decreasing with wetness, until a value is reached corresponding with the maximum internal cohesion of the damp materials. A test suitable for measuring the consistency of stiff plastic mortar or concrete is described by Cloyd M. Chapman in the *Proceedings* of the American Society for Testing Materials for 1913. This test "consists in depositing the mortar or concrete in a form of suitable size and shape resting on a nonabsorbent surface, such as glass or metal, and then removing the form and noting the settling or sloughing down, either with or without the assistance of a jar or shock, of the unsupported mass of paste, mortar or concrete left standing." The test is stated by Mr. Chapman to be useful only for material that is "not too fluid to have a tendency to retain its form when at rest." It is thus applicable to concretes stiff enough to require tamping for consolidation in practice.

In experimenting upon the heap test a number of trials were made, forming the heap of concrete by placing the material in a form, such as a bottomless inverted pail, and removing the latter as in the test above described by Mr. Chapman. The heaps obtained in this way with mushy and wet mixtures gave less uniform and satisfactory results than were obtained by pouring the concrete out of a pail.

The Heap Test Defined

The results of the preceding observations may be summarized in a specification for the consistency of concrete. The amounts in parentheses are given as illustrative for mushy concrete, and not as absolute values applicable to all materials and conditions. "The concrete shall be mixed to such a consistency as to form a heap whose height is not less than (one-tenth) nor more than (one-fifth) of the average diameter of its base, when poured as follows: A sample of the concrete of volume not less than $\frac{2}{3}$ cu.ft. is placed in a pail or tub and poured from the same slowly, in one place, on a level impervious surface, and with as little free fall as possible, stopping as soon as the concrete begins to pile up so that the slope near the center is steeper than near the edge. If in this test water separates from the concrete so as to surround the heap in a ring more than ($\frac{1}{4}$) in. in average width at one minute after pouring, the consistency will not be considered satisfactory." A more complete specification covering this test should mention the method and place of taking an average sample, the number of occasions on which the test is to be made and the responsibility for the labor involved.

The $\frac{2}{3}$ cu.ft. specified to be used in making the heap test is intended to apply to mixtures with aggregate up to about $1\frac{1}{2}$ in. in diameter. For coarser aggregates this quantity should be increased. In making the test the height of the heap is most readily found by thrusting a wire or small stick down through the concrete. The point at which the concrete begins to pile up at the center of the heap was well marked in the concretes on which experiments were made. If this point is slightly overrun in pouring out the concrete, the projecting fragments of coarse aggregate should not be included in measuring the height of the heap.

Concretes Used in Tests

The concretes used in making the tests described were 1:2:4 mixtures using local sand and screened gravel. How the numerical results would vary with other materials would have to be determined by trial. While a series of experiments applying the heap test to a large variety of materials would be interesting and valuable, those already made show the correctness of its two essential features: That for the consistencies ordinarily used in practice there is a close measurable relation between the wetness of the concrete and the height-to-diameter ratio of the heap and the width of the separated watering. The inference that the latter indicates the tendency toward segregation, while not proved, seems reasonable.

The consistency of concrete which it is best to use on any given work is a matter of judgment, depending on many variables. For this reason caution should be used in writing numerical values in the heap-test specification without knowledge of local materials or conditions. What is usually needed is something to make the results of judgment permanent and uniform, so that when a desired consistency of concrete is once secured with given local materials, it may be exactly duplicated at any time. The heap test is well adapted to this purpose.

Water Losses at Columbus

Although only 63% of the water consumed in Columbus, Ohio, goes through meters, according to the latest annual report of the Water Department, the percentage of services metered is 96.12. The consumption is 82 gal. per consumer, 87.1 gal. per inhabitant and 475.1 gal. per tap. The percentage unaccounted for is 25, and the loss by under-registration of the meters is 8%. The cost per million gallons pumped, based on actual running expenses, is $57.35. When interest on bonds and sinking fund is charged in, the cost is $86.38.

Macadam Reconstructed as Bituminous Macadam

Cheap and Simple Method Produces a Smooth and Hard Surface at a Cost of 37 Cents a Yard

By HAROLD J. SPELMAN

Assistant Engineer, New York State Highway Department, Le Roy, N. Y.

IN RECONSTRUCTING 5520 ft. of macadam, a bituminous mat 1 in. thick was removed, the top course loosened by scarifier, harrowed, rolled, treated with bitumen and given a wearing surface at a cost of 37c. per sq.yd. With the exception that perhaps too small a quantity of dustless screenings was used on the surface, resulting in an inadequate filling of the macadam voids, the road is in excellent condition.

Remove Mat Resulting from Maintenance

Originally the road leading from Batavia, N. Y., to Buffalo was a two-course waterbound-macadam pavement, 6 in. thick and 16 ft. wide, built in 1907. A considerable number of holes and depressions had developed, and the road had become very rough. A roller hauling a light scarifier was first used to loosen the bituminous mat, which was about 1 in. thick, care being taken to avoid loosening the old macadam surface. The mat was removed by a road machine, after which the few patches of bituminous mat remaining were removed by pick.

The scarifier was then used to loosen up the old 3-in. top course. Crushed limestone ranging in size from 1¼ to 2½ in. was spread over this surface at the rate of 1 cu.yd. to 45 sq.yd. The road was then crowned and shaped by hand-forking and gone over thoroughly with a team-drawn agricultural weeder, which worked the screenings and stone dust and sand to the bottom and gave an open surface for the asphalt. Any pockets of fine material that showed up after the surface was rolled with a 10-ton roller were removed by hand and filled with fresh stone of the proper size, as were any depressions that developed during the rolling.

Hot Binder Applied Under Pressure

Asphalt binder, meeting the New York State specifications for "Bituminous Material A Penetration," was then applied under 50 lb. of air pressure at the rate of 0.70 gal. per sq.yd. from a team-drawn pressure distributor equipped with a firebox that kept the asphalt at 300 deg. F. The air compressor was driven from the rear wheels of the wagon.

Immediately following the application of the asphalt, the binder course of limestone, ranging in size from ¾ to 1¼ in., was spread by hand at the rate of 1 cu.yd. to 41 sq.yd. This was then thoroughly rolled and shaped by the 10-ton roller, followed by the application of a seal coat of 0.50 gal. to the square yard. Dustless screenings of pea size were spread by hand over the surface at the rate of 1 cu.yd. to 50 sq.yd. The road was thoroughly rolled and broomed and immediately opened to traffic.

The quantity of dustless screenings used was perhaps insufficient, and it would be desirable to increase the quantity to 1 cu.yd. to 40 sq.yd. The quantity used was hardly sufficient properly to fill the voids in the surface, though examination after two months' traffic shows the surface to be smooth and hard. The asphaltic cement drawn to the surface gives the general appearance of a new penetration bituminous road. It is believed that this type of reconstruction can be used advantageously where the traffic has increased to such an extent as to make the original waterbound type unsuitable and where the funds for resurfacing are limited.

The length of road treated was 5520 ft., the width 16 ft. and the area, therefore, 9810 sq.yd. The total cost, exclusive of engineering and advertising, was $3718, or $3540 per mile and 37c. per sq.yd. These figures include all labor and material and about $80 worth of stone and asphalt left on the road for general-maintenance purposes. Actual cost data kept showed that the contractor made a small profit.

The work was begun on July 17 and completed on Aug. 7, 1916, by Sweeney & Boland, of Rochester, N. Y., under the direction of the State Highway Department, the writer being in charge of the work for the state.

Wood-Stave Pipe Will Deliver Everett's New Water-Supply

On Pipe Line 27 Miles Long Metal Pipe Will Be Employed for 5 Miles Where Head Exceeds 350 Feet

By R. E. KOON

Supervising Engineer for Burns & McDonnell, Consulting Engineers, Kansas City, Mo.

TWENTY-TWO miles of wood-stave pipe will be a feature of the new water-supply for Everett, Wash., to be obtained from the Sultan River. The works, now under construction, consist essentially of a low rock and timber crib diversion dam on the river, approximately 20 miles of 28-in. continuous wood-stave pipe, 5 miles of 28 x ¼-in. riveted steel pipe and 2 miles of 22-in. continuous wood-stave pipe.

WHERE POSSIBLE THE PIPE IS BUILT ON CRADLES ABOVE GROUND

THE FIRST SECTION OF PIPE LAID FOR EVERETT, WASH., WATER-SUPPLY

There will be four tunnels in rock aggregating a total length of 1760 ft. Two navigable streams, the Snohomish River and Ebey Slough, will be crossed by means of 30-in. class D, flexible-joint, cast-iron pipe. These streams are each about 30 ft. in depth, and their combined width is 572 feet.

Wood pipe will be used for heads up to 350 ft., and steel and cast-iron pipe are to be used above that head to a maximum of 450 ft. The rate of fall in the pipe line will be approximately 1.5 ft. per 1000. Wherever possible, the wood pipe will be built on cradles above the ground and will be given a protective coating of water-gas tar, followed by a coat of coal-gas tar on those portions of the line where the head is less than the saturation head.

At the city end of the pipe line the water will be discharged into the existing 10,000,000-gal. reservoir and distributed through the present system of water mains.

The work was designed by Burns & McDonnell, consulting engineers, Kansas City, Mo., and by the writer, who is now supervising engineer for the project.

City Engineers Should Be the City Planners

Future of This Work in America Rests Largely with the Engineers Who Must Execute as Well as Plan

By THOMAS ADAMS

Town-Planning Adviser, Canadian Commission of Conservation, Ottawa, Ont.

THE progress of city planning schemes on this continent depends on municipal engineers more than on any other body of men. In cases where they have not the power or the opportunity to initiate schemes they have both the power and the opportunity to press forward or to retard schemes initiated by others. Municipal engineers are gradually improving the status of their profession, and tardy appreciation of the value of their services is being shown by public authorities. Changes in forms of government and in official titles take place, but at each successive step the trained and qualified engineer becomes more firmly entrenched as the sane executive officer. As a rule, when cities give up their city engineers and appoint managers they either appoint the same men under the new name, to assume greater responsibilities, or they use the occasion to get a better engineer. The final result is to broaden the functions and develop the qualities of the engineer. That is the tendency—and it is a sound one. Until more confidence is shown in the men who have to administer the complex engineering problems of the modern city, cities will not get men worthy of confidence.

Broader Vision and Collaboration Essential

As the position of the municipal engineer becomes strengthened, his vision will become broader. He will be more inclined than hitherto to look on the city problems as a whole and to apply attention to the consideration of the future development of the city in all its parts. He will become a city planner with the local knowledge necessary to make him a sound adviser, and with the local power necessary to give effect to his ideals. If he has lack of imagination and architectural training, he may be wise enough to employ an artist to help him with the æsthetic part of the work.

Collaboration is essential in city planning. The municipal engineer, when he begins to develop his opportunities, must avoid the mistake being made by members of other professions in trying to deal with every aspect of the plan of a city. The engineer, the architect and the landscape architect must act together, but it is the municipal engineer with his official standing who should be responsible for bringing about the scheme of coördination. It is true that the engineer needs the special training of the city planner in addition to his own and that he must buy his experience. But as, in the end, he will have to be primarily responsible for the execution of any city plan or development scheme that is prepared, then the sooner he begins to fit himself for the duty the better for city planning and his own position.

City Engineer Must Both Plan and Execute

To appreciate properly the importance of the municipal engineer in relation to a city plan, we have to realize that, apart from the civic center and the public buildings, in respect of which architectural advice should always be employed, he will be responsible for the detailed execution of the plan. Who has the greater power for good or ill, the man who prepares a plan or the man who—himself knowing something of planning—carries it out?

City planning has primarily to do with future development. Its function is to prevent bad development taking place rather than to cure evils that have become established. The former can always be done; the latter is frequently impossible and always difficult to do. To make a plan and prepare a report is useful only as a guide to enable a development scheme to be prepared. It is the development scheme that matters, not the plan. A poor plan followed by good development is better than an excellent plan followed by bad development.

Planning Must Get Beyond Paper

City planning in America has largely consisted in preparing plans and reports. The results have been disappointing, because no development scheme has been prepared to carry out the plan. Planning is not an end in itself; it is only a means to an end. Therefore, so long as our city planning goes no farther

than paper reports, we will achieve little. Why have the results of all the efforts and all the publicity given to city planning in the United States been so few? The reasons may be many, but in my judgment one reason is that city planners have failed to enlist the active sympathy and help of municipal engineers.

It appears to have been assumed that the only way to plan a city is to get a report by outside experts, made in many cases to an irresponsible commission. The skilled specialist has his functions, and America has some city planners of great ability who are doing excellent work for the country; but until the city authorities and their engineers take up city planning, little real progress will be made. Adequate legislation has first to be obtained to enable planning and development schemes (not merely street and park plans) to be prepared. That legislation should provide for the greater part of the work of city planning being done either by the elected authorities who have control of the purse strings, or by commissions appointed by and responsible to them.

Engineers Do Town Planning in Great Britain

Nine-tenths of the town-planning schemes in Great Britain are being prepared by engineers. The chief town-planning inspectors in England are architects with engineering experience, and in Scotland the inspector is an engineer with an architect as his assistant. The only completed schemes in England have been prepared by municipal engineers. A British scheme cannot be prepared by experts not in daily touch with the territory included in the scheme and not officially responsible to the City Council for its execution. The outside expert may advise and may prepare the skeleton plan, but in practice he must do so in coöperation with the local engineer. The latter alone has the knowledge and the equipment necessary to undertake the preliminary surveys, the negotiations with numerous owners, the preparation of the plans of streets, sewers, etc., and the drawing up of estimates of cost. The Town Planning Institute formed in Britain has three classes of members comprising architects, municipal engineers and surveyors and a fourth class of legal members consisting of lawyers with experience in drafting town-planning schemes.

The professors of town planning in London and Liverpool are architects, but there is an engineering lecturer attached to the Liverpool chair. The students largely consist of men in training for positions as municipal engineers. The municipal and county engineers of England and Wales have their own society and hold an examination in town planning.

Until legislation is in force in the United States similar to that which exists in Britain, the municipal engineer will not be made to realize his responsibilities in regard to city planning; but it is in his interests and in the interests of the movement that he should take up the study of the subject.

Society of Municipal Engineers Needed

There is need in Canada, if not in the United States, for a Society of Municipal Engineers to protect the interests of those members of the profession who are specializing in all work of a municipal character. It is not to be expected that the senior engineering societies comprising specialists in many other fields will take up city planning and other civic questions seriously. The rapid growth of cities, the growing expenditures on public works and the increasing complexity of municipal problems of an engineering nature require a highly trained and well-organized group of men. One reason why they need a special organization is because they are subject to influences on the part of city councils which do not affect other kinds of specialists and because their salaried positions make them more vulnerable to attack from privileged interests. There is also great need for promoting education in municipal engineering in the same way as is being done by the Institution of Municipal and County Engineers in England.

The publication of Nelson P. Lewis' book on "The Planning of the Modern City" has provided engineers with an excellent introductory textbook. A national conference of municipal engineers to discuss city planning in all its aspects should be held to consider what steps should be taken to stimulate engineers to take more interest in the subject. City planning has come to stay; and while its progress can be said to depend on the municipal engineer, it may also be claimed that the future of the municipal engineer will depend on his attitude toward city planning. The successful city engineer in days to come will be the man who has acquired the kind of knowledge necessary to prepare a comprehensive development scheme of a city—who has trained himself to visualize the lines of future growth and to understand how best to regulate its tendencies, and who in his daily routine works toward the realization of the practical ideals that he has conceived in the process of preparing his scheme.

Air-Compressed Water Washes Filters, Obviating Pump

Off-Peak Utilization of Equipment Already Available Cheapens Installation Cost of Rapid Filters at Lawrenceville

HAVING on hand two sheet-steel tanks of 29,000-gal. capacity and an air compressor with plenty of off-peak time, the designers of the Lawrenceville filter plant were enabled to eliminate the purchase of a wash-water pump, the compressor being available to store up sufficient air under pressure on top of the water to wash the filters.

The plant, which has only recently been put into operation, consists of two rapid filters of 180 sq.ft. filtering area each, with the usual system of strainers fitted for washing at a rate of 2 ft. vertical rise per minute, with water only. The two tanks, shown in the photograph alongside the filter building, were formerly used on the distribution system as storage tanks and pressure equal-

OLD TANKS USED FOR COMPRESSED-AIR STORAGE

izers. The engineers considered it advisable to use these tanks since they were available, rather than to scrap them and purchase a large pump and possibly an air blower, both of which would stand idle much of the time.

In washing a filter the procedure is as follows: Starting with the tanks three-fourths full of water, air is pumped in through a 2-in. line until a pressure of 25 lb. per sq.in. has been attained. The air line is then shut off adjacent to the tanks, and the compressor fills an air-storage reservoir of 340 cu.ft. of free air to a pressure of 80 lb. per sq.in. This storage is on the air line leading to the wash-water tanks. When the required pressure is attained and the storage opened into the line, the filter wash is started. By proper manipulation of the wash-water valve an even wash can be maintained at the required rate. When the filter has been washed, the air pressure is released and the tanks refilled from city service. The only objection reported to the procedure is that the operator may be careless and not give proper attention to the manipulation of the wash-water valve, in which event it is possible to blow up the sand bed.

The plant belongs to the Central Illinois Public Service Co., for which M. S. Dutton is engineer in charge.

River Straightening Again Active at Cleveland

Committee of Engineers, Acting Semiofficially, Present New Plans as Flood-Prevention Measure

ENTIRELY new plans for straightening the Cuyahoga River at Cleveland have been developed by a committee of engineers acting semiofficially under the auspices of city, county and other authorities concerned. Major P. S. Bond, United States engineer in charge of the Cleveland district, County Engineer W. A. Stinchcomb, City Engineer Robert Hoffman, and E. B. Thomas, formerly river and harbor engineer of the city, worked out the plan. The Chamber of Commerce, Cleveland, has been pushing the matter.

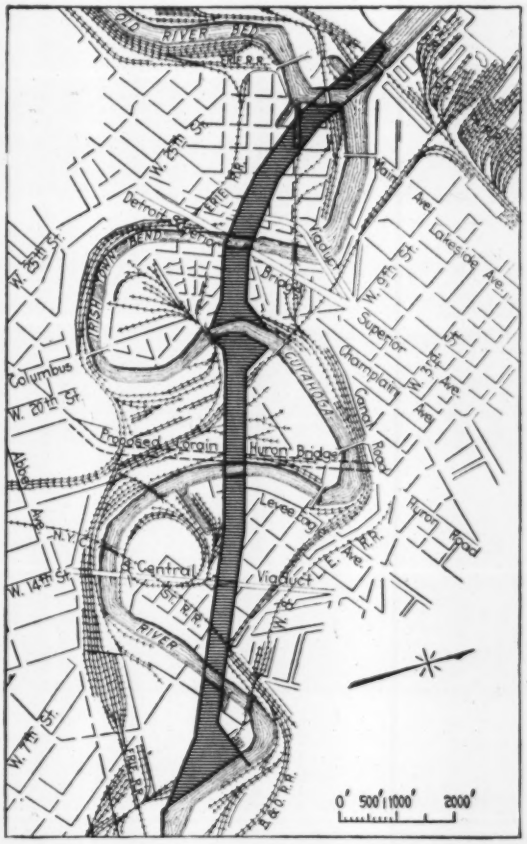
A new feature of the situation is that, while former river-straightening plans were based primarily on navigation needs, the present project is made immediately urgent by the need of bridge construction and is going to be put through—if the recommendations are followed—as a flood-prevention measure, utilizing the state conservancy law.

The map herewith shows the location of the five or six large cutoffs constituting the scheme. An area of 62 acres would have to be dredged. The existing bends would be in part filled and in part retained as slips for shipping purposes. The improved length is 10,000 ft., against a present length of 19,200 ft. The cost of the project is estimated for the present at about $7,000,000.

The proposed channel is to have 250 ft. minimum width and 22½ depth. It is laid out straight between three tie-points: The inner end of the river-mouth piers, the steel arch span of the new Detroit-Superior viaduct and the proposed channel span of the Lorain-Huron viaduct.

Plans were developed some years ago for straightening the river with a view to making the large factory-site areas of the upper portion of the Cuyahoga Valley available to iron-ore steamers, which now unload adjacent to the river mouth. Two proposals were worked out, with channels lying respectively west and east of the channel now proposed, but each costing only half as much as the new scheme. Neither one afforded a complete or satisfactory solution of the navigation difficulties, however.

Flood-prevention purposes have not heretofore been given any particular weight in the Cleveland river-straightening plans. The proposal of a special committee of the Chamber of Commerce is, however, to utilize the state Conservancy law, under which flood-prevention or drainage districts may be formed, to carry out this river-



PROPOSED SCHEME WOULD ELIMINATE MANY BENDS

straightening project. The idea appears to be to assess benefits on the basis of flood protection afforded to the individual pieces of property. The immediate motive, however, is the necessity of relocating the river at the proposed Lorain-Huron viaduct in order to make construction of this viaduct possible.

The vote for $5,000,000 for this viaduct on the part of the county last fall limited the alignment of the structure in such a way as to bring it into an unfavorable location with respect to the river, as the map shows. The county engineer's estimate for the cost of the viaduct included $1,500,000 for channel improvement. This is not sufficient for any generally useful channel change. Moreover, the authority of county officials to spend money voted for bridge construction in channel-improvement work is doubtful, and state legislation to give them clear rights in this direction has already been introduced for action at Columbus.

Growth of Filter Sand at Three Water-Softening Plants

History and Experiments at Columbus, Ohio, Grand Rapids, Mich., and McKeesport, Penn., Given in a Series of Three Articles

Incrustation of filter sand passing water treated with lime for softening purposes largely increases the effective size and reduces the uniformity coefficient. The sand growth and the loss of sand in washing result in an eighth of the original sand ultimately filling the filter tank to its original sand surface level.

Part I—Nine Years' Experience at Columbus

By CHARLES P. HOOVER
Chemist-in-Charge, Water-Softening and Purification Works, Columbus, Ohio

FOR filtering softened water such as is treated at Columbus, Ohio, sand is undoubtedly the best medium known, although it is far from satisfactory, because the sand grains, by adsorption of the normal carbonates from the softened water, soon become incrusted or coated with carbonates of calcium and magnesium, and oxides of iron and alumina.

Recent analyses of the sand in the Columbus filters show that this incrustation amounts to 88.3%, leaving only 11.7% of the sand originally placed in the filters. The balance has been washed away through the wash-water discharge. The remaining 11.7% of sand has become so enlarged that the depth of the bed has not been lowered by reason of so much sand having been lost.

The incrusted sand (the term calcide instead of sand has been suggested by A. E. Kimberly, consulting engineer, Columbus, Ohio) when dried resembles fish eggs. The coating or incrustation is gradually getting larger, as shown by the following analyses:

	Effective Size, Mm.	Uniformity Coefficient
1908 (original sand)	0.415	1.36
1913	0.62	
1917	0.95	1.17

The beds have not only become so coarse as to make them inefficient for filtering turbid water, but the calcide grains cement themselves together, forming hard lumps, which become as large as bushel baskets and are so hard that they have to be dug out of the bed in order to be broken up. This lumping of the sand prevents the wash water from breaking through the sand beds uniformly and also causes the rate of filtration to be high in parts of the bed. These conditions have become so bad during the past year that, when the turbidity of the settled water exceeds 15 parts per million, it is necessary to add excessive amounts of alum to the water, as it is applied to the filters, in order to obtain a bright sparkling effluent. It is also necessary to watch carefully the effluent from the filters during periods when the turbidity of the settled water exceeds 15 parts per million, because the filters soon become loaded, allowing turbid water to pass through them. Samples are collected every few hours from the controllers during periods of muddy water, and on the first indication of a smoky effluent the filter is washed.

Low Turbidity at Columbus Fortunate

Fortunately, however, the turbidity of the settled water at Columbus is very low, it having averaged 6 parts per million during the year 1916 and only exceeded 15 parts per million on 34 days during the year. This low turbidity of the settled water is obtained because of the good sedimentation effected by the subsidence of the heavy precipitate of calcium carbonate and magnesium hydroxide produced by the lime-soda ash treatment.

Some time ago there was a break in the stem of the valve of one of the filters, and the bed was idle for about four months. The sand became thoroughly dry and when the filter was again washed it was found to be entirely free from lumps. It was suggested by Mr. Kimberly that perhaps the filter could be dried rapidly, by blowing air through it. This was tried, but without success.

The sand beds at Columbus are used for removing (1) turbidity and (2) colloidal alkalinity. The bacteria are largely eliminated by the lime treatment and by hypochlorite disinfection.

Filtration Necessary in Softening Process

The alkalinity or temporary hardness of softened settled water is lowered by filtration through sand; therefore filtration is necessary as a final or finishing step in the softening process. A possible explanation of this reduction of hardness by filtration is that the lime and soda ash combine with the magnesium and form a colloidal precipitate of basic carbonate of magnesium, which is removed or retained by the filters. The addition of alum to the settled water is also a great help in removing this colloidal alkalinity (*Engineering News*, Sept. 17, 1914). Although the removal of this colloidal material from the water by retaining it on the sand beds results in filter difficulties, it is advisable to remove it before the water is pumped into the distribution system, because if it were not removed by the filters it would very probably be deposited on the walls of the distribution system and in the meters.

The results shown in the following table indicate that the beds have not lost their efficiency for removing colloidal alkalinity or temporary hardness:

TOTAL ALKALINITY (PARTS PER MILLION)

Years	Settled Water	Filtered Water	Decrease
1909	51	40	11
1910	58	50	8
1911	49	45	4
1912	55	46	9
1913	70	61	9
1914	59	47	12
1915	63	51	12
1916	66	57	9

Plant experiments, which have already been referred to, show, however, that the filters have lost their efficiency for removing turbidity. The results of the following laboratory experiment indicate the extent of this inefficiency.

Two small experimental laboratory filters were recently built, one being filled with 24 in. of sand (effective size, 0.95 mm.; uniformity coefficient, 1.22) taken from one

of the regular filter beds in service at the plant, and the other filter filled with washed sand taken from a sand bank located on the grounds of the purification works (effective size, 0.34 mm.; uniformity coefficient, 1.85). Samples of raw river water having a turbidity of 115 parts per million and a coefficient of fineness of 0.66 were treated with alum in amounts ranging from 1 to 4 grains per gallon. It was found that the samples treated with 1.5 grains of alum per gallon and filtered through the fine sand filter came through the filter sparkling clear, whereas it was necessary to use 4 grains of alum per gallon to obtain a bright sparkling effluent from the filter containing the incrusted sand from our own filter beds.

Experiments on Eighteen Samples

On Jan. 9, 1917, eighteen samples of sand were collected from one of the filters, as follows: Six samples from the surface of the filter, six from 1 ft. below the surface and six from 2 ft. below the surface. These samples were taken from each corner and each side opposite the center. They were sent to the laboratory of the Ohio State Board of Health, where they were analyzed by L. H. Van Buskirk, director of laboratories, and J. S. McCune, chemist. The average results of analyses are shown in the following table:

SAND ANALYSES, WATER-PURIFICATION WORKS, JAN. 10, 1917

From	Effective Size			Uniformity Coefficient		
	Front	Center	Back	Front	Center	Back
Surface	90	96	96	1.22	1.17	1.16
1-ft. depth	90	95	96	1.21	1.15	1.15
2-ft. depth	92	95	96	1.19	1.15	1.15

The portions of sand retained on sieves of various numbers were analyzed separately, and the results are shown in the following table:

CHEMICAL ANALYSES OF FILTER SAND *

Material Retained on Sieve No.	Silica SiO_2	Iron and Alumina Fe_2O_3—Al_2O_3	Calcium Carbonate $CaCO_3$	Magnesium Carbonate $MgCO_3$	Hygroscopic Water	Combined Water and Organic Matter
6	28.75	2.00	56.54	10.64	0.85	1.22
10	35.50	2.70	49.59	7.99	2.20	2.02
14	8.50	3.40	74.84	8.78	2.25	2.23
16	9.05	2.45	77.67	6.97	1.95	1.91
20	8.50	2.40	76.98	7.61	2.15	2.36
24	12.95	1.75	65.51	10.30	2.05	7.44
30	21.80	1.90	44.41	10.60	1.10	20.19
30-140	8.45	2.80	71.09	14.16	1.20	2.30
Composite	11.70	2.65	74.84	6.93	1.30	2.58

* Chemical analyses made by Arthur H. Flower, assistant chemist, Columbus Water-Purification Works.

The results of sieve analyses show that the effective size and the uniformity coefficient are very nearly the same at all depths at which samples were taken, proving that the incrustation is general throughout the whole filter. It will also be noted that the effective size of the sand taken from the front of the filter is slightly less than the effective size of the sand taken from the center and back.

Incrustation Resistant to Hydrochloric Acid

A composite sample of sand or calcide was treated with hydrochloric acid in order to remove the incrustation. It was desired to get 100 grams of sand so as to make a sieve analysis. The material being only about 11.7% sand, it was therefore necessary to treat about 1200 grams. It took about two days and a 9-lb. bottle of hydrochloric acid to get 100 grams of clean sand free from incrustation. The reason that it took so long was because the acid had to be added slowly; otherwise, the effervescence and foaming was such as to cause an overflow from the pan in which the sand was being treated. The analysis of this acid-treated sand was as follows: Effective size, 0.41 mm.; 60% less than 0.63 mm.; uniformity coefficient, 1.54. Philip Burgess, consulting engineer, Columbus, Ohio, suggested that a large quantity of the sand be sieved, and samples be made as follows: Sample 1 material retained on sieve No. 6; 2 on No. 10; 3 on 14; 4 on 16; 5 on 16; 5 on 20; 6 on 24; 7 on 30; 8 on 30 to 140. Each sample so obtained would be acid treated, and then a sieve analysis would be made in order to find out the size of the matrix present in each separation. In other words, the object would be to find out whether or not the coarsest material present in the bed now had grown from the coarsest material originally placed in the bed or, vice versa, if the smallest particles now in the bed were built on or around the finest original particles.

On account of the difficulty of removing the incrustation from the sand this suggestion was not carried out. Instead, 61.6% of the total sand sieved through the nest of sieves was collected on sieve No. 20 (0.93 mm.), and after acid treatment this material analyzed as follows: Effective size, 0.41 mm.; 60% less than 0.54 mm.; uniformity coefficient, 1.32. The analysis of the original sand was: Effective size, 0.415 mm.; uniformity coefficient 1.36. The results of this test as well as the results of the analysis of the composite sample after acid treatment indicate that the matrix of the calcide grains now present in the filter does not differ from the original sand.

Will Try Resanding One Bed

The difficulties encountered in obtaining a bright sparkling clear water during the past year at periods of muddy water have demonstrated the necessity of resanding the filters, and we now contemplate renewing the sand in one of the beds as soon as the weather will permit. The resanding of this bed will be more or less of an experiment, as additional data are needed to answer the following questions before renewing all the filters: How fine should the sand be when installed? What is the proper depth? What should be the distance from the surface of the sand to the edge of the wash-water gutters? What rate of washing is most effective?

In this one filter the sand will be 18 in. deep instead of 30 in., as originally. The effective size of the sand will be between 0.30 and 0.35 mm. instead of 0.415; the sand will probably not be graded, on account of lower cost and as it will soon approach uniformity in size through incrustation. The filters will be washed with wash-water controllers wide open, which should wash at a rate of 20 in. vertical rise per minute. The distance from the surface of the sand to the edge of the wash-water troughs will be 19 in. and the depth of gravel will be 15 in. With this filter in operation, valuable comparative data will be obtained by comparing results of analyses of the effluent obtained from this filter with the effluents obtained from the other filters. The results obtained will be made public as soon as they are available.

Before closing, it may be noted that, when L. H. Menzies, United Water Softeners, Ltd., Imperial House, Kingsway, London, England, visited the Columbus plant in the last week of November, 1916, he suggested that we might overcome our difficulties with the sand beds by filtering a portion of the raw water through permutit, and by so doing the permutit-filtered water would contain residual sodium bicarbonate, which would neutralize the normal carbonates present in the settled water. This

would amount to the same thing as carbonating the water, and would no doubt overcome the sand troubles.

Finally, I have not intended to convey the idea that the difficulties encountered with the sand beds are such as to make municipal water softening impractical. As I pointed out in a previous paper ("Advantage of the Use of Lime in Water Purification," *Engineering News*, Sept. 17, 1914), the use of lime for softening a water-supply has other advantages in addition to procuring soft water. Briefly, they are summarized as follows: (1) Intestinal and pathogenic bacteria are killed, rendering the water safe bacterially. (2) The water is clarified. (3) Color is removed. (4) Water softened by lime and soda ash is not corrosive to iron pipes; thus no trouble is experienced from the accumulations of "red water" in dead ends of the distribution system. (5) The sterilizing action of lime persists indefinitely. These advantages are such as to make softening worth while.

In treating water such as we have at Columbus, the results that we have obtained indicate that the sand will have to be renewed about once in eight years.

[*Next week: "Five Years' Experience at Grand Rapids," by Walter A. Sperry.*]

Pennsylvania Changes at Baltimore Under Discussion Again

Company Would Expand Calvert Terminals and Main-Line Tunnel System—City Engineer Proposes New Freight Tunnel

THREE ordinances were presented Jan. 29 to the Baltimore City Council by the Pennsylvania R.R. looking to the improvement of the company's facilities in that city. Within the last month, an engineer for the city, requested by the mayor to report on the situation, has offered a very different solution of the problem, which has long been under discussion. The railroad company would expand its present plant—by the construction of new parallel tunnels for its main tracks through the city, and by the acquisition of additional land and the changing of streets at the site of the Calvert terminal at the end of the Northern Central R.R. The city's representative recommends that the additional main-line trackage be obtained by a new tunnel under Franklin St., connecting with existing freight lines, and forming a new route through the city for freight, passenger service being retained on the present main line. The Calvert St. freight terminal would be replaced by a new one at Central Ave. and Fleet St.

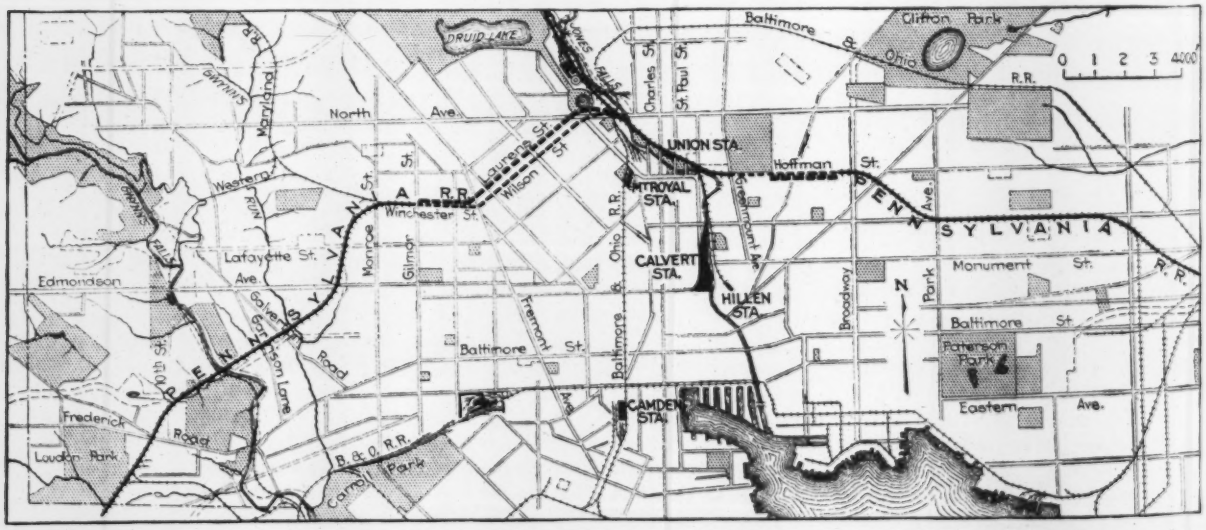
Railroad Plan

The main line of the Pennsylvania passes through the city in a generally east and west direction, well to the north of the business center. The Union Station is in the open, in the valley of a stream known as Jones Falls, between Charles and St. Paul Sts., the open cut extending about 2000 ft. each way. To the east of this cut, however, the double-track line is in a 3300-ft. tunnel under Hoffman St., emerging at Bond St. and passing over a number of streets before leaving the city, while to the west it occupies a 7600-ft. tunnel under Wilson and Winchester Sts., emerging near Gilmor St. and then swinging to the southwest, passing over or under numerous streets and crossing two at grade before reaching the city line.

The Northern Central R.R., a subsidiary of the Pennsylvania, coming down the valley of Jones Falls, joins the main line near the east portal of the west tunnel, passes through the Union Station, turns off to the south along Jones Falls and terminates a mile nearer the heart of the city, at Calvert Station. The Pennsylvania's main local-freight facilities are along this Calvert St. extension of the Northern Central's main line into the heart of Baltimore.

The Baltimore & Ohio R.R. passes through the heart of the city in another tunnel, north and south, from Camden Station to Mt. Royal Station. The Western Maryland R.R. uses the west tunnel of the Pennsylvania from Monroe St., and reaches its own terminal—Hillen Station.

For the main line the solution proposed by the Pennsylvania, as shown on the accompanying plan, contemplates



IMPROVEMENTS PROPOSED BY RAILROAD ARE TWOFOLD, INVOLVING ADDITIONAL MAIN-LINE TRACKAGE AND AN ENLARGED CALVERT TERMINAL

independent double-track twin tunnels—south of but adjoining the present tunnel on private right-of-way along Hoffman St. and north of and similarly adjoining the present tunnel for a short distance along Winchester St. For the most part, however, the west tunnel would occupy a new location under Laurens St., a block north of the present line under Wilson Street.

In building the new tunnels the company desires to avoid as far as possible the heavy grades of the existing tunnels and at the same time improve the profile all the way to the west city line. Coming in from the east on an approximately level grade, the present tracks begin a sharp descent at Broadway, passing down through the Hoffman St. tunnel on a 1.14% grade. Crossing the Jones Falls Valley, they ascend through the Wilson St. tunnel on a 1.324% grade to a point near the curve into Winchester St., continue the ascent on lighter grades nearly to Lafayette Ave. and then descend on a 0.93% grade to Gwynn's Run, where the tracks are 10 ft. lower than the four-span bridge over Gwynn's Falls. The ascent to this bridge is on an easy grade, but west of the bridge the tracks go up on an 0.82% grade to Ellamount or 10th St., thence passing out of the city on a comparatively light descending grade.

Improved Profiles

Under Hoffman St. the new tunnel will necessarily have the same 1.14% grade, the subgrade being 2½ ft. lower to give more headroom. It is proposed, however, to convert the westerly 1250 ft. of the tunnel into open cut, moving the old and new portals back three blocks. This will make it possible to shorten the 1.14% grade by the 1250 ft., the Greenmount Ave. overhead crossing being raised 8 feet.

West of the Union Station extensive grade changes are contemplated. Beginning considerably east of the present tunnel, the ascending grade for the Laurens St. tunnel will be reduced to 1.14%, the same as that for the Hoffman St. tunnel (in the opposite direction). Because of the break in the old profile near the turn in the tunnel, the new subgrade will be only slightly lower than the old at the Monroe St. bridge. At this point, however, it will begin a comparatively light descent, getting 14 ft. below the present summit. This will eliminate the present heavy grade and at the same time permit the construction of a viaduct to carry Lafayette Ave. over the tracks without prohibitive street changes.

The two profiles would cross under the Edmondson Ave. bridge, from which point the new subgrade would gradually rise above the old, at once eliminating the Gwynn's Run sag and raising the tracks at the Warwick Ave. and Garrison Lane grade crossings to permit undergrade crossings. Calverton Road, a grade crossing at present, would be closed.

West of Gwynn's Falls the ascent would be reduced to 0.5%, making more headroom possible under Ellamount St. and Frederick Road without materially changing the profiles of those streets.

Terminal Improvements Especially Pressing

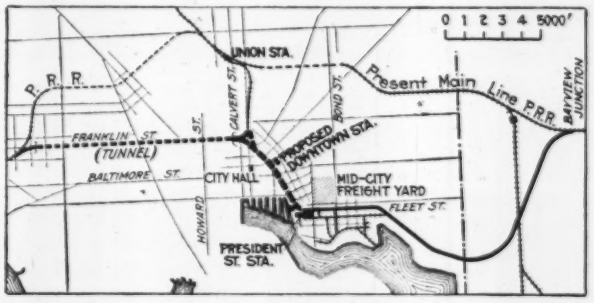
The changes proposed on the Northern Central branch are quite different in character, but from a standpoint of commercial growth of Baltimore and its increased business and prosperity the Calvert St. improvements are more pressing than the main-line changes.

The ordinance proposed calls for the vacation of certain streets and for changes in the grades of others, to permit the reconstruction on a much larger scale of the Calvert terminal with new overhead streets instead of grade crossings. The ordinance plan shows three new freight sheds and extensions of five existing sheds; also a milk platform, a grain elevator, team tracks for 240 cars, and numerous storage tracks. The development embraces the site of the Calvert passenger station, to replace which new passenger facilities are to be constructed. The company has heretofore expressed the belief that Calvert Station should be used solely for freight traffic and that the Northern Central passenger trains should not run beyond the Union Station. So far the city has not assented to that proposition and has been urging electrification of the old and new lines and facilities.

Numerous minor changes are also proposed. The estimated cost of the entire improvement is $11,800,000. The plans have been developed under the direction of A. C. Shand, chief engineer of the Pennsylvania Railroad.

Mr. Lee's Plan

In the report prepared by Walter E. Lee, water engineer of the city, at the request of the mayor, Mr. Lee assumes as a fundamental that schemes such as have been presented for one tunnel for all roads would not be acceptable to the Pennsylvania. He questions whether the matter of terminal facilities is as important to the company as that of main trackage for through freight. He holds, too, that the critical section is the west tunnel, which must carry not only all Pennsylvania freight between the east and the south, but also freight between the west and the south, via Harrisburg and the Northern Central, and a considerable amount of Western Maryland freight. And he points out that a reverse movement is necessary for all of this Northern Central traffic, this being irremediable because of the difference of grades of the Pennsylvania and the Northern Central west of their junction.



CITY OFFICIAL PROPOSES SEPARATE FREIGHT TUNNEL

His proposition, therefore, is to make use of existing freight and industrial lines south of the main line, and build an entirely new tunnel for freight only. By locating this under Franklin St., a considerable distance south of the present west tunnel, it would be possible to make a direct connection with the Northern Central near the present Calvert St. Station, while the construction of a comparatively short length of new depressed line would reach the existing freight line at President St. Station. Thence the route would continue along the harbor basin and get back to the main line at Bay View Junction.

At the west end connection with the main line would be made just beyond the tunnel portal.

This plan would give a straight tunnel 10,400 ft. long, 1150 ft. longer than the total length of tunnels proposed by the Pennsylvania. It would also involve the purchase of a certain amount of expensive land for the connection along Jones Falls, and the construction of an inverted siphon to get this waterway under the connection.

Freight Only in New Tunnel

Freight traffic only would be operated over the new route. The present main line and Union Station would continue to carry the passenger traffic. For commutation service Calvert Station would be replaced by a new downtown station facing the new civic center to be opened east of the city hall.

This scheme would not permit of the expansion of the Calvert St. freight terminal, and Mr. Lee believes no such expansion should be allowed, other than the complete development of all the property now owned by the railroad. Rather than create what he believes would be a considerable barrier to surface traffic in the center of the city he would assign for freight-terminal development a new district to the southeast, bounded by Central Ave. and Pratt, Bond and Fleet Sts.

One other recommendation is that the company be required to electrify its lines through the city, and that it be prohibited from even hauling steam locomotives through. This would necessitate electrification of the entire section—probably from Wilmington to Washington on the main line and for some distance on the Northern Central.

State Lands in Colorado To Be Appraised

The Colorado State Board of Land Commissioners has announced the undertaking of the classification and appraisal of all the lands owned by the state, aggregating approximately 3,500,000 acres. The plan contemplates the making of detailed reports to be placed on file in the office of the board at Denver, these reports to cover all important matters relating to each subdivision of land, including its topography, geology and mineral resources, both surface and underground water resources, character of vegetation, cultural features, location with respect to towns, transportation facilities, and all other matters affecting values, so as to provide for a determination as to both the present and the ultimate disposition of the lands. Ten appraisers have been appointed for the purpose, all men familiar with such work, the fieldmen being equipped with automobiles, and both field and office work are now under way.

In general, there will be a careful field examination, followed immediately by a detailed report to the office, where the field report will be studied and amplified by the office engineers, through the addition of such recorded data as may already be on hand or may be found through study of Geological Survey, Forest Service, Hydrographic or other official records available. Special investigations, timber cruising, etc., may follow, and the report may later be verified or amplified in the field to any extent desired.

It is expected that the work will be completed by Nov. 1, 1917. The entire classification and appraisal is under the immediate supervision of John E. Field, engineer, member of the board.

Oregon Enacts New Irrigation-District Code

State Engineer Will Have Large Measure of Control

By PERCY A. CUPPER
Assistant State Engineer, Salem, Ore.

THE Oregon legislature at its session just closed enacted a complete irrigation-district code and repealed all laws on this subject then on the statute books. The code was prepared by a committee, of which the writer was chairman, appointed by the Oregon Irrigation Congress. The plan is applicable not only to new projects, but also to the operation and maintenance of constructed works, including Carey act and United States Reclamation Service projects.

Under the new code the organization of the district, which is a quasi-municipal corporation, is initiated by filing a petition with the County Court. If the court approves, an election is called, land owners voting. The district is governed by a board of three directors. The state engineer is required to approve or disapprove the plans prepared by a competent engineer appointed by the Board of Directors or plans adopted by the board. Final payment to any contractor constructing the irrigation-district works shall not be made until the constructed works have been approved by the state engineer.

Bonds for Any Purpose

Bonds of the district bearing not over 6% interest may be issued for any purpose whatsoever, including the repayment of bonded indebtedness or interest on bonds for a period of three years. The funds for the payment of the expenses of the district, including the interest and principal on bonds, are raised by assessment on the lands according to benefits, levied in the same manner as state and county taxes are levied and collected by the county officials. Provision has been made for the assessment of irrigated or partly irrigated lands within the district prior to the time the water rights for such lands are acquired by the district. This feature eliminates the necessity for increasing the bond issue for construction work so as to include the purchase of water rights.

Certification of Bonds

Undoubtedly the most important addition to the irrigation-district law of Oregon is the provision relating to the certification of irrigation-district bonds. The state engineer, the attorney general and the superintendent of banks are required upon application of any irrigation district to make a thorough investigation as to the feasibility of the project, the water-supply, the fertility of the soil, and determine whether or not the value of all property within the district subject to assessment, including works to be constructed, rights-of-way and lands to be acquired by the money arising from the sale of the bonds, is equivalent to twice the amount of the bonds issued. If in the judgment of these officials the bond issue meets the requirements of the statute, the secretary of state is directed to certify the bonds. After certification the bonds are legal investments for all trust funds and the funds of all insurance companies, banks, both commercial and savings, trust companies and bonding companies.

Air Diffusion in Activated Sludge

Entrained Air Introduced by Downward Sewage Jet Prolongs Air and Sewage Contact—Further Large-Scale Studies Needed

By WALDO S. COULTER

Hansen & Coulter, Consulting Engineers, New York City

UNQUESTIONABLY the methods at present used in the activated-sludge process for applying air to sewage are extremely wasteful. In the brief time during which the air passes from the bottom of the tank to the surface of the liquid but a small percentage of its oxygen is utilized. Comparing the volumes of air now required with Rideal's statement that only ½ gal. of air would be necessary for the nitrification of the nitrogenous matter contained in 1 gal. of English sewage, assuming the atmospheric oxygen to be fully utilized, we get some idea of the low efficiency of current methods.

Problem To Prolong Contact Period

If some means could be devised for successfully prolonging the period of contact of air and sewage, it is conceivable that, besides lessening the volume of air applied in the usual manner, it might bring new methods within the scope of practicability. It is, for instance, a matter of common knowledge that water falling into a pool will entrain air bubbles; and if the fall and volume be sufficiently great, the air bubbles will be numerous and driven down to considerable depths. The amount of air so entrained is not equivalent to the present requirements of the activated-sludge process unless the height of fall be made unreasonably great. If, however, the time of contact were sufficiently prolonged, this method of introducing air might prove feasible.

Having in mind the development of some simple method for securing this prolongation of contact, A. E. Hansen and the writer have conducted a series of tests, both on a working scale and with glass models, during the past six months. While our efforts have not been attended with the success we had hoped for, some interesting points were brought out and a brief description of our work may not be amiss.

The working-scale experiments were made at the sewage-testing station of the Borough of Richmond, New York City, at West New Brighton, and those with glass models at the office of Hansen & Coulter. The sewage-testing station was used by the courtesy of Henry P. Morrison, Borough Commissioner of Public Works.

Entraining Air By Sewage Jet

After some preliminary work at the testing station it was decided that prolongation tests could be made more rapidly and with better opportunities for observation on a small scale with glass models. Subsequent work at the testing station was confined to tests to determine the best method of directing a jet into the sewage for the purpose of entraining air. These latter tests showed that a given discharge of sewage dropping freely from a height of 3 or 4 ft. into a vertical pipe extending 7 or 8 ft. below the surface forced air readily from the submerged end of the pipe, the quantity of air remaining about the same after diminishing the submergence to 5 or 6 ft. Various methods of introducing the sewage at the top of the drive pipe were tried, including a form of injector and a vortex chamber, but the most effective method found consisted in simply directing the jet vertically downward into the open pipe. The drive-pipe arrangement failed, however, to entrain as large a volume of air as did the same flow of sewage discharged directly onto the surface of the sewage in the tank. As observed later in the glass models, the penetration of the bubbles was somewhat less without the drive pipe. The volume of air entrained by the fall through 3 or 4 ft. was obviously insufficient, even though the period of contact were greatly increased. Owing to the absence of facilities for varying the height of the drop within the desired limits, work was discontinued at the sewage-testing station.

Prolonging Air-Contact Period

Working with glass models, efforts to discover some method of prolonging the period of contact were directed along two lines: (a) Increasing the length of travel of the air bubbles through the sewage, and (b) breaking the air bubbles into extremely small globules, so that they would be driven back by currents and diffused throughout the sewage, from which they would be but slowly dissipated.

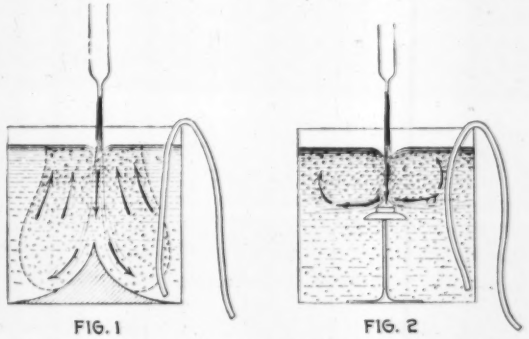


FIG. 1 FIG. 2

TWO METHODS OF AIR DIFFUSION IN SEWAGE

Efforts toward securing prolongation in aërating tanks into which air was forced in the usual manner were confined to attempts to break up the air into what might be termed an "air mist," similar to air-charged water drawn from a tap. It was assumed that, if a certain amount of water was delivered into the compressed-air supply pipe and the air and water together broken up by violent collision such as occurs in the chamber of a spraying nozzle, some such effect might be secured while producing sufficient agitation to keep the sludge in suspension. Arrangements were made for the discharge of the air and water under considerable excess pressure at the bottom of the tank through "Spraco" nozzles, kindly lent for the purpose by B. C. Donham & Co., New York City. This nozzle is provided with a small central passage surrounded by spirally arranged tubes, all leading to a "collision chamber" in the upper portion of the nozzle, and breaks water into a very fine spray.

The subdivision of air obtained in this manner, while very complete and comparing favorably with that resulting from the use of filtros plates, did not give the air-mist effect for which we were looking.

As regards the introduction of air by means of a jet of sewage, it was found that a jet having a velocity of about 25 ft. per sec., equivalent to a drop of 10 ft., delivered into a drive pipe, entrained approximately an

equal volume of air. Discharged upon the unobstructed surface of the water in the vessel, the amount of air entrained appeared to be much greater, but no means was found to measure the volume of air that would not interfere with the action of the jet.

Jet Impinging on Submerged Cone

The best means found for increasing the length of travel of the air bubbles was that shown in Fig. 1. The bubbles driven downward were deflected by the peak below and diverted well toward the sides of the vessel before rising. The bubbles driven farthest from the center did not rise directly upward, but came back somewhat toward the center, as indicated by the dotted line. A smooth, flat metal surface, if not too large in diameter, placed at a point below the water surface where the jet still retained sufficient velocity to deliver a strong blow, served to break the bubbles and throw them out toward the sides of the vessel, as shown by Fig. 2. This device also produced many very minute air bubbles that would remain suspended for some time below the field of agitation. It was not possible to secure appreciable action, however, if the metal surface were placed well down in the jar.

Efforts to break up the air bubbles and make them so small that the liquid would be freed from the air slowly, have not been so far successful. Some results in this direction were secured from the arrangement shown in Fig. 2, but nothing that could be applied in practice was developed.

It is possible that the increased length of travel afforded by the downward and upward path of the bubbles, with considerable lateral motion (Fig. 1), may be sufficient to afford the requisite prolongation of contact, but this can be determined only by actual operation. It should be borne in mind that what was sought in these jet experiments was not altogether means for producing complete activation with a high degree of nitrification, but an inexpensive method of securing sufficient activation to produce at least a very complete clarification.

Experience to date has demonstrated that an equivalent degree of clarification can be secured with much less air and with a shorter detention period than is required for the complete process.

In view of the simplicity of the jet method, we believe that the idea is worth trying out on a working scale as an incidental feature of a testing station.

Marine Type of Diesel Engine Adapted to Water-Works

Latest Designs for Stationary Pumping Units Are To Be Found in Dutch Installations—Accessibility of Working Parts a Feature

By THOMAS ORCHARD LISLE
Member American Society of Mechanical Engineers, New York

ONE of the common complaints made by users of Diesel engines for power-plant purposes is that such motors lack accessibility and that considerable time and labor are expended when the machinery receives its regular overhaul or when piston rings become gummed. A comprehensive idea of what can be done in the way of designing a stationary-type Diesel engine that is ideal from an accessibility point of view may be obtained from the accompanying illustrations of the sets installed in the municipal water-works of the City of Amsterdam, Holland. There can hardly be any doubt that, so far as this feature is concerned, the design is a distinct advance over anything domestic builders have produced.

Perhaps this is to be expected, because of the more extended experience with Diesel-type engines some of these European engineers have had. For instance, the concern that built the engines in question—the Nederlandsche Fabriek van Werktuigen en Spoorweg Materieel, of Amsterdam—was one of the original Diesel licensees and has been engaged in such work for more than 18 years.

Marine Engines Adapted to Stationary Use

How the engines mentioned, which differ radically in design from those of a few years ago, attained their present form is interesting. About six years ago this company turned its attention to Diesel engines for ships and gradually developed a machine along the lines of its marine steam engine, having realized that accessibility is essential when at sea and that the stationary-engine design was unsuitable for the more strenuous work of propelling a ship.

This marine engine proved so successful that the company decided to adopt its general features for stationary purposes, and it was not long before it decided to scrap its conventional designs of stationary models and build them with the chief marine constructional features incorporated; the engines illustrated in this article resulted. As might be expected, they were most successful in practice, for what will stand the stresses set up in a moving hull by 40- and 45-day nonstop runs at sea in storm and calm should easily bear the duty of operating on a heavy and fixed concrete foundation.

The Amsterdam Engines

The two engines in the Amsterdam water-works are four-cylinder sets of 500 b.-hp. each, coupled to generators, while the other stationary engine (Fig. 2) is a six-cylinder set of 1500 hp. that formed one of five generating sets now operating in the Dutch East Indies. To give an idea of how these engines were developed from the marine model, there is illustrated (Fig. 3) a six-cylinder marine set of 1100 b.-hp., only the latter has an extra camshaft and cams, for reversing purposes.

First, we will deal with the Amsterdam water-works installation, which differs in several points from the larger engines. These engines run for 36 days and nights and then are stopped. Piston rings are overhauled, cleaned and the engines started up again for another 36-day nonstop run, which they consistently perform. It is during these short stops that the greatest value of the accessibility of design is felt, for a piston can be taken out, rings cleaned and replaced in about 1½ hours without disturbing

any piping or valve gear, which is possible with no other design. This accessibility has been brought to its unusual condition by reason of the engine being quite of the open crank-pit type, with the cylinders mounted on steel columns, while strength and rigidity are added by steel cross-stays, with the crosshead guides on cast-iron frames at the back of the engine. To the steel columns detachable steel plates are fitted to prevent the lubricating oil from being thrown out by the connecting-rods.

The cast-iron columns at the back of the engine are not bolted to the cylinders, but have a sliding-surface fit. Their chief function usually is to carry the crosshead guides and the bearings for the beam-levers of the air compressors and cooling-water pump. Being hollow, some of the columns are used as intercoolers for the air compressors. But in this particular instance Reavell compressors are driven off the forward end of the crankshaft.

Cylinder Design

The cylinder proper is separate from the outer jacket, which is a simple box casting that virtually forms a tank into which the cylinders are "dropped" and secured in position by studs. This method enables the cylinder liner to be cast integral with its head and is the only four-cycle Diesel design whereby there is complete circulation of water round the upper part of the sides of the combustion chamber as well as on top. This design gives water cooling exactly where it is needed, because it is there that the greatest center of heat occurs. Hence, cracked cylinders or heads now are entirely eliminated. With detachable heads it is necessary to have heavy flanges at this point; and where there is such solid metal, the water cannot flow to cool the metal and thus absorb the surplus heat.

An important part of the design is that the portion of the cylinder which extends below the jacket is detachable and may be unbolted, thus facilitating the easy removal of any piston without dismantling any portion of the engine and so saving many hours of tedious labor. The pistons are water cooled, this being carried out by means of clearance pipes and a pressure jet. The advantage of this piston-dismantling device is particularly felt when a low grade of fuel oil is being used, because after long periods of steady running at full power it becomes extremely advisable, and sometimes imperative, to remove the pistons and clear the rings of the carbonaceous deposit that causes them to stick and thus results in loss of power.

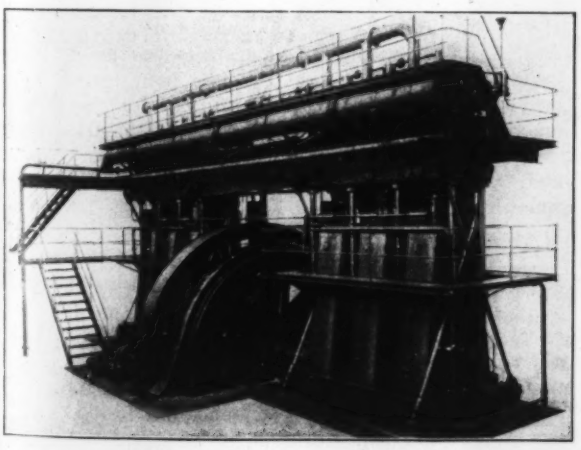


FIG. 1. A SIX-CYLINDER SET OF 1500 HP. NOW OPERATING IN DUTCH EAST INDIES

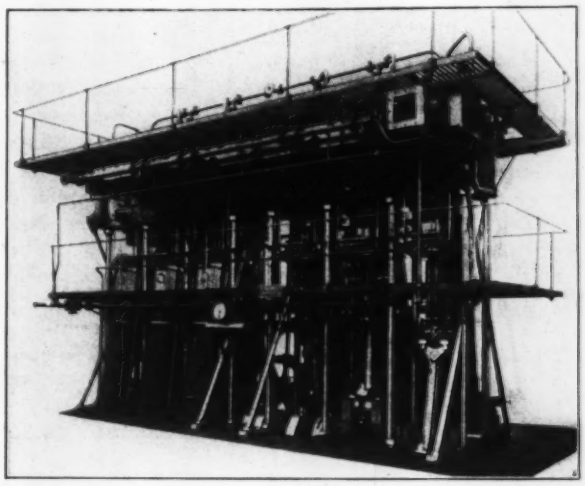


FIG. 2. THIS IS AN 1100-B.-HP. MARINE TYPE FROM WHICH THE STATIONARY-TYPE ENGINE WAS DEVELOPED

Just below the detachable cylinder extension is a cast-iron tray that performs several minor functions, one of which is to collect any water that may come from the piston connection and prevent its dropping into the lubricating oil in the crank pit. It also collects the carbonaceous deposit (formed by burned lubricating oil) scraped off the cylinder walls by the piston rings. If this found its way into the bearings, it might do considerable harm. When it is desired to take out a piston, the cylinder extension is lowered onto this tray, and a pair of wrought-iron rails are rested on it. The piston rod is then disconnected, and the operation of sliding the big piston along these rails is accomplished without effort or the use of a crane.

Lubrication by Forced Feed

Lubrication of the cylinders, pistons and crosshead guides is by force feed; but sight-feed drip is used for the main bearings and crankpins. The camshaft is actuated by means of a vertical shaft; but with the larger engine illustrated the marine drive has been adopted—that is, the camshaft is turned by four cranks, driven by four long vertical rods, actuated in turn by a similar set of cranks mounted on the cast-iron bedplate and operated off the engine main crankshaft by spur gearing. These rods really are long steel tubes, saw cut down the centers, pried open and held apart in the middle by short struts. In this way vibration is eliminated, and no other camshaft drive is so smooth and quiet in operation. It will also be noticed that the larger engine is divided into two three-cylinder units with a central flywheel and the generator in the flywheel—quite a novel arrangement for a Diesel engine.

Motor Runs on Mexican Crude Oil

To illustrate what a Diesel engine can use in cases of emergency, we may add that at the works of the Nederlandsche Fabriek a test motor ran without trouble and

for a considerable period on Mexican crude oil of the following analysis:

Specific gravity at 15° C	862
Flash point (closed test)	140° F.
Calorific value	17,430 B.t.u.
Sulphur	4.6%
Asphaltum	70%

This, of course, is an exceedingly heavy oil, the percentage of sulphur and asphaltum being excessive. It was only successfully used under the most favorable conditions. Contrary to the general impression, the presence of a moderate amount of sulphur in the oil does not cause an ill effect on the exhaust valves and cylinders, provided, of course, proper care is taken to keep away moisture. Some of the engines in operation have successfully and regularly run on Taraken, a crude oil with a specific gravity of about 0.94. With a very heavy-oil fuel, starting is carried out on a lighter residual oil, such as gasoil or fueloil, and the engine is run on the same [illegible] for about half an hour each day, which cleans [illegible] pistons, etc., of the deposit left by the dirty oil.

There would appear to be a very large market [illegible] stationary-type Diesel engines in Holland and [illegible] colonies, and many water-works use this class [illegible] including the Zaandam water-works and the [illegible] water-works, also the Government lighthouses. [illegible] land there are about seven hundred *polders*, consisting of reclaimed land lying below sea level, inclosed by [illegible] ments and requiring constant drainage. Throughout these *polders* the Diesel engine built by the Nederlandsche Fabriek has been adopted, and the powers vary from 50 to 500 b.-hp. per engine. During the recent terrible inundations these engines were used for pumping out sections of the country and demonstrated their reliability.

Use of Trenching and Backfilling Machines From Maine to California

Practice and Experiences of Cities and Contractors in Water-Works, Sewerage and Other Construction Gathered and Summarized

THE growing difficulty of getting labor at any price in 1916 turned the attention of many cities and contractors engaged in water-works and sewer construction more and more toward the use of trenching and backfilling machines. To get a general idea of the practice and opinion in this field, inquiries were sent to correspondents of this journal. Since the information was gathered, the need for utilizing all possible labor-saving machinery has become even greater than it was in 1916. Summaries of the report follow:

Massachusetts Cities and Contractors

Boston, Mass., and Vicinity—Neither the City of Boston nor the Metropolitan Water and Sewerage Board uses trenching or backfilling machines. The same is true of contractors on work for the City of Boston. The presence of pipes and other conduits makes it necessary to open city streets with great care, so the digging must be done by hand. Machine backfilling is impracticable under the conditions just named, since the material must be put back in small quantities to insure the consolidation essential to satisfactory pavement replacement. The town of Milton uses no machines. The water-works superintendent thinks that for shallow water-pipe trenches, with obstructions, machines would not pay. The Brockton Gas Co. uses or has used a trench machine. The Water Department of Worcester uses a trench machine. Experience of a Boston contractor has been reported as follows:

"One Boston contracting concern began using machines about five years ago on work at Mattapoisett, Mass. It did not have great success on account of cobbles in the excavation, which the machine did not handle well. Owing to the labor shortage, it again adopted machines and in the fall of 1916 used a trench machine on country work in Maine, for laying about 18 miles of 14- and 16-in. pipe in a trench about 5 ft. deep and 2 ft. wide. The makers of the machine claimed it could excavate 1000 ft. a day, but the contractor was unable to get more than 700 or 800 ft., and the average day's work was nearer 300 ft. The success of the equipment depended on having an operating force capable of making repairs, and it was essential that a complete supply of parts be carried. The cost of operation was said to be about 5c. per lin.ft. of trench. The pipe laid was partly wood and partly cast iron."

Fred T. Ley, general contractor, Springfield, Mass., used a machine at Southboro, Mass., on a conduit for the Edison Company.

Springfield, Mass.—Labor conditions that are leading to the adoption of trenching machines are stated in the following extract from the 1916 report of A. E. Martin, superintendent of water-works, Springfield, Mass.

"Such work as might have been accomplished during the year was further delayed and held back by the labor situation, which has handicapped the department in all its work during the past season. During the winter of 1915-16, the laborers of the city formed a shovelers' union, and a strike for higher wages was instituted to take effect on Apr. 1. The outcome of this strike was an agreement by arbitration of a rate of 30c. per hour for an 8-hour day, or $2.40 per day as a minimum for shovelers' or laborers' pay. The city was paying $2.25. If overtime was worked, the agreement called for 32c. for the ninth and 35c. for the tenth consecutive hour, and for all time in excess of 10 hours, also Sundays, the laborer was to receive pay at a rate of 1½ hours for each hour worked.

"It was early decided by our city solicitor that the city could not discriminate between its citizens to the extent of running a "closed shop," so called; but the above scale of wages was adopted by the different departments, and all laborers' pay in this department was raised in proportion, averaging a raise of 6⅔%. Notwithstanding the above raise in pay, it has been impossible to keep men in our pipe-laying gang, every man who was not getting at least $2.75 per day deserting us for higher wages with contractors, so that our regular pipe-laying gang, which

usually carries from 30 to 50 men, has been reduced to 10, [illegible] of whom are old standbys who have been with us for upward of 10 to 15 years. In consequence of the above handicap we have been unable to keep up with our extension work, and there are several such extension orders that will have to go over until next season; if the shortage of men continues, a trenching machine will become a necessity for a part of our equipment for the coming year."

Central New York as Observed by an Engineer

Central New York State—A consulting engineer of wide experience reports that from observation in various cities the following notes have resulted: "It is possible to use a trench machine successfully in city streets even where there are numerous underground obstructions, such as gas mains, sewers and the like, provided the locations of these pipes are known. In one city a trench machine has been successfully used and has passed over many hundreds of underground gas and water connections with only a single breakage of a gas service—that one breakage occurred in a case where the gas company had failed to advise the water company of the existence of a gas service.

"One difficulty experienced in the use of trench machines in certain soils is that the trench machine generally operates much more rapidly than a single gang of pipe layers can follow up with the pipe laying. In some cases it has accordingly been found advantageous to operate the machine intermittently, opening up the trench only one or two lengths of pipe in advance of the pipe laying, so as to avoid caving of the banks and the necessity of shoring the trench.

"While less useful for excavating loose materials overlying rock, nevertheless the use of trench machines for the purpose appears to be entirely practicable, since slope-cutting devices can be applied and the trench thereby cut with sufficient bottom width and sufficiently flat side slopes so that, when the rock is blasted, the amount of caving of the earth will be reduced to a minimum."

Pittsburgh, Baltimore and Farther South

Pittsburgh Water-Works—E. E. Lanpher, Bureau of Water, Pittsburgh, Penn., summarizes local conditions adverse to the use of trenching as follows: "Many streets abound with pipe and other obstructions; soil conditions are such that trenches more than 3 ft. deep will not stand without bracing; ground in residence sections, where machines might otherwise be used, is full of hard flinty limestone niggerheads; street-car tracks are often in the way. As to machines being used more for sewer than for water-main trenches, Mr. Lanpher says that sewer trenches are 10 ft. deep against an average of 4½ ft. for water trenches."

Baltimore, Md.—Walter E. Lee, water engineer of this city, was highly pleased with a trenching machine recently bought for his works.

North Carolina—The City of Charlotte does all water-works trenching by hand, but the trenches are generally rather shallow. Contractors at Charlotte are reported on by our correspondent as follows:

"About three years ago the contracting firm of Dabbs & Myers used a power tamper in refilling some sewer trenches here, with satisfactory results both as to cost and efficiency. The trenches so filled have given us no trouble about sinking, while those filled and tamped by hand in work done by other contractors have had to be constantly looked after for a considerable time after completion. No cost figures are available, but on account of the abundance of cheap and efficient labor in this section, there would be little saving compared with hand labor.

"The firm of Sullivan, Long & Hagerty used a trenching machine on a sewer contract in Charlotte about 2½ years ago. Some effective work was done with this machine on several streets where the depth of excavation was from 6 to 10 ft. Some saving in cost as compared with hand labor was claimed."

The Central West

Cleveland, Ohio—Two contractors here report that the use of trenching machines has been satisfactory. One of these contractors had four in use on a single job a few months ago. The trenching-machine successes of another contractor are attributed to getting or training capable men and keeping them on the job.

Detroit, Mich.—The rapid growth of Detroit in area and population due to the automobile industry has created a demand for water-main extensions and industrial conditions in that city have put labor at such a premium that the city resorted to a trenching machine in 1916.

The Twin Cities—Minneapolis is proud of what is believed to be the only municipally owned water-works trenching machine in Minnesota, which it uses for large mains. Machines for small mains may be adopted later. The St. Paul water-works has been investigating trenching machines for several years and may soon be forced to use them, owing to labor conditions. Sewer contractors in St. Paul "are well equipped with machinery and by keeping it constantly employed they are able to win out, but some of them feel they are carrying quite a heavy investment load."

Reports from California

San Francisco, Calif.—Trenching and backfilling machines are but little used in this city. For sewer-trench excavation steam hoists, moved along the trenches, are used to raise and lower buckets. In outlying districts, where there are few pipes on the streets to give trouble, several trenching machines have been used.

Southern California—Our correspondent at Los Angeles reports:

"It is my belief that there is an equal amount of trenching done with power machines for water-works construction and for sewer construction. However, on the whole there is a less amount of backfilling done by machinery for both sewer and water-works construction. The Water Department of the City of Los Angeles has two power backfillers and a good many trenching machines. Possibly the reason for the scarcity of power backfillers is due to the fact that most of the construction work is for small trenches and the contracts are generally let to contractors who are not able to afford such equipment, so that the greater part of their backfilling is either done by hand or with slips.

"In San Diego County there are no trenching machines or power backfillers. The reason for this is that most of the sewer trenches are of small dimensions and water pipes are seldom buried to a depth greater than 2 ft. below the ground surface. The larger part of the backfilling is done by hand, slips or go-devils. On the larger trenches road graders are often used for backfilling."

Highway Commission Standardizes Sizes of Stone and Gravel

Coöperation with Engineers and Producers Reduces Chaos to Order and Will Result in More Perfect Separation of Sizes

REALIZING that the present demand for standard-size rock and gravel for road purposes, and for well-graded aggregate for concrete, finds its greatest obstacle in the lack of uniformity of screen sizes at various stone-crushing plants and gravel pits, the Wisconsin Highway Commission coöperated with the Crushed Stone Producers Association, the Wisconsin Society of Engineers and State Chief Engineer J. G. D. Mack, with the idea of establishing standard screen sizes and standard numbers by which the various sizes might be known. The results of several conferences have been very satisfactory, and the State Highway Commission has recently notified all those who might be interested that the adopted numbers and sizes will be used as standards on all state and state-aid construction.

It is hoped that architects and engineers engaged in other than state work will find it possible to assist in the realization of the benefits of this standardization by having their specifications call for material in accordance with the adopted sizes.

Fewer Sizes Mean Better Separation

The members of the Crushed Stone Producers Association have agreed that, as they renew their screen, they will install screens which will furnish materials complying with the standard. The new classification, reducing as it does the number of screen sizes in many cases, should enable the producer to put in longer screen lengths for each standard size and thus secure a better separation of the material, especially in the smaller sizes. The standard sizes and numbers are as follows:

No. 1—Material retained on a 2-in. circular opening and passing a circular opening not greater than 3½ in. in diameter. (Note: Plants may furnish as No. 1 material products retained on a 2-in. circular screen and passing a circular screen 3½ in. or less in diameter.)

No. 2—Material retained on a 1-in. circular opening and passing a 2-in. circular opening.

No. 3—Material retained on a ½-in. circular opening and passing a 1-in. circular opening.

No 3½—Material retained on a ¼-in. circular opening and passing a ½-in. circular opening.

No. 4—All material passing a ¼-in. circular opening. (Note: A passing screen smaller than 2 in. may be used for gravel, quartzite, granite and traprock aggregate, provided it is not less than 1¼ inches.)

State Road Specifications Simplified

In the future, state road specifications will call for No. 1 stone for first course of macadam; No. 2 stone for the second course of macadam; and No. 4 for screenings. These two sizes are, in effect, the same as those advocated by the office of Public Roads, though in the latter case the maximum dimension is 1½ in. for the second, or wearing course. Nos. 3 and 3½ will not be used in new macadam construction, except that possibly 3½ may be used for preliminary screening in certain cases. For one-course concrete roads, specifications will call for material retained on a ¼-in. screen and passing a 2-in. screen, with no intermediate sizes removed. This will, therefore, be a combination of all materials included in Nos. 2, 3 and 3½.

For two-course concrete-road work, the specifications will call for a first course of the same aggregate as for one-course concrete construction. For the second course, coarse aggregate will consist of material retained on a ¼-in. screen and passing a 1-in. screen, with no intermediate sizes removed—a combination, therefore, of Nos. 3 and 3½. On other work other combinations may be used; but while the five sizes specified will ordinarily be separated in the process of production, it is possible, by mixing sizes, to produce material meeting a large number of specifications. The range of sizes thus secured is believed to be adequate for all architectural and engineering purposes.

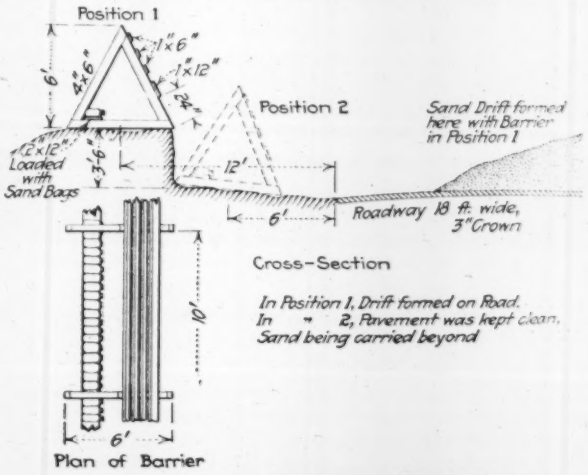
Sand-Drift Barriers Protect Road Across Desert

California Highway Commission Experiments with Methods of Keeping Highways Clear

THE Highway Commission of California last year built a plank road through the Imperial Valley desert, described on page 131 of the *Engineering Record* for July 29, 1916. When the road was constructed, it was realized that difficulties with drifting sand would be experienced. The method of combating this, however, was left to be worked out when it could be dealt with as a condition rather than as a theory. That the sand did drift across the road in a troublesome manner is shown by one of the photographs, which was taken eight months after the road was put in service and clearly shows the conditions obtaining at a number of points along this stretch of the state highway.

Experiments with Sand Fences

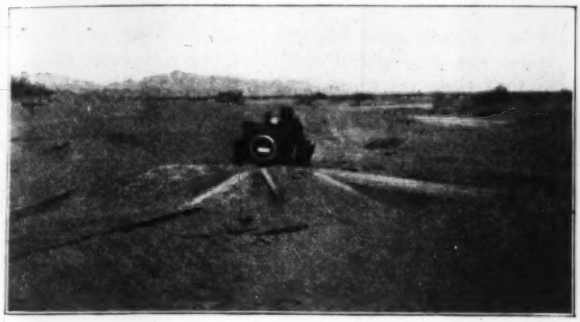
For immediate relief from this condition the maintenance forces worked with horse-drawn scrapers, but meantime experiments are being made with wooden bar-



SUCCESS OF DRIFT BARRIERS DETERMINED BY LOCATION

riers that are built up something like snow fences and are calculated to prevent the formation of drifts on the road. The only results thus far available in the drift-barrier experiments have to do with a section of 18-ft. road on a sandy, wind-swept portion of the state-highway system. Here the road is paved with concrete; it has a 3-in. crown and is surfaced with asphaltic oil and screenings.

The drift barrier first tried for this road was placed at about 12 ft. from the nearest edge of the paved strip and at a slightly higher elevation, as shown in the accompanying sketch. In this position the barrier caused the sand drift to form on the far side of the pavement. The barrier was then moved to position 2, as indicated in



SIMPLE WOODEN FENCE CONSTRUCTION KEPT OPEN DESERT ROAD IN CALIFORNIA WHICH HAD FORMERLY BEEN COVERED HUB-DEEP WITH DRIFTING SAND

the sketch. Here the effect was to cause the sand to blow clear across the highway, effectively preventing the formation of the troublesome drifts.

Wind Deflected

The drifting sand is generally very close to the ground. The finer dust that is carried higher up in the air does not cause road trouble. The design of the barrier was therefore worked out with the purpose in mind of deflecting the wind downward, increasing the velocity close to the ground. With this action the tendency would be to carry the sand on for some distance rather than to permit it to collect in drifts near the barrier. The frames on which the barrier is supported were built up in the shape of an equilateral triangle, and 4 x 6-in. posts were used for this frame simply because this happened to be the size of material on hand and most conveniently available. The planking was put only on the side next to the road and the bottom stringer on the side of the barrier away from the road was weighted down with sand bags.

The experiments are being carried out by the California State Highway Commission, A. B. Fletcher, chief engineer.

Hypochlorite and Liquid-Chlorine Costs

Hypochlorite and liquid chlorine at Indiana water-treatment plants in 1916 averaged 8.5 lb. of hypochlorite and 1.8 lb. of liquid chlorine per 1,000,000 gal. of water treated. The average costs were 5.3 and 16c. per lb. respectively. Continuing the comparison, liquid chlorine costs only 60% as much for material as hypochlorite. These figures were taken from a paper read by Philip Burgess, of Columbus, Ohio, before Indiana Sanitary and Water-Supply Association in February.

Dimensions of Storage Tanks for Economical Design

Problem Arose in Designing Special Reservoir with Concrete Bottom and Steel Sides—Formulas in Terms of Unit Costs

By ARTHUR JOBSON
Casper, Wyo.

IT IS often desirable, in the design of storage tanks or small reservoirs, to obtain such dimensions that the construction cost will be a minimum, particularly where the dimensions depend only on capacity. The solution of this problem becomes of more than usual interest where the material for the bottom is different from that of the sides. The writer in designing a special reservoir with concrete bottom and steel sides, without backfill, worked out a solution for a general case. This was done by finding expressions for the cost of the sides and the bottom, adding them to get an expression for total cost and equating the first derivative to zero.

The final equations obtained are as follows:

$$R = \sqrt[4]{\frac{V^2 w_1 w_2 c_1}{\pi^2 S c_2}} \qquad (1)$$

and

$$d = \sqrt{\frac{S c_2}{c_1 w_1 w_2}} \qquad (2)$$

in which R is radius in feet; V, capacity in cubic feet; w_1, weight per cubic foot of material in sides; w_2, weight per cubic foot of reservoir contents; c_1, cost per pound of installing sides; c_2, cost per square foot of installing bottom; S, allowable unit stress in pounds per square foot for material in sides, and d, depth in feet.

It is interesting to note in equation 2 that the proper depth for the lowest cost is independent of volume or capacity. For any assumed capacity the depth will be constant for given values of unit stress, costs of installing sides and bottom, unit weight of contents and unit weight of side material. Trial computations with equation 1 will show that for the value of R giving the lowest cost the cost of installing the sides and bottom will be approximately equal, as they should be theoretically.

The quantity c_1 is intended to include all expense for labor and material in connection with the cost of installing the sides, and c_2 may not only include the expense for labor and material in laying the bottom, but

also the cost of grading and leveling the reservoir site. In the use of these equations, S should be assumed rather small, for two reasons—to allow for efficiency of riveted joints and to proportion properly the thickness of vertical sections of the plate so that the actual net area may approximate the theoretical area used for computing weight and cost. For steel plate with an ultimate strength of 60,000 lb. per square inch, a factor of safety of 4, and a joint efficiency of 70% the writer found that the value of S to be used was about 1,296,000, or 9000 lb. per square inch.

Sides of Constant Thickness

If the side-plate thickness is arbitrarily selected without reference to the depth or diameter, the expressions for the most economical dimensions become:

$$R = \sqrt[3]{\frac{tVw_1c_1}{\pi c_2 S}} \qquad (3)$$

and

$$d = \frac{Rc_2}{tw_1c_1} \qquad (4)$$

where t is plate thickness in feet.

If the value for R given by equation 3 is substituted in the total-cost formula, it can be shown that the dimensions giving the lowest cost result in making the cost of the sides equal to twice the cost of the bottom, as against these costs being equal where the thickness of the plate is assumed to vary either with the depth or with the diameter of the reservoir.

Warns Young Engineers About South America

Advantages That May Be Derived from a Ten Years' Residence Should Not Obscure Understanding of All Factors

By B. T. MOOTE
Whiting, Ind.

THE advisability of a trip to Latin America depends on several important considerations, and each young man who contemplates going should decide the question entirely from his own point of view after he has weighed these matters carefully. The decision is not a trifling one, as it will probably have much to do with shaping the young engineer's career.

One of the first considerations of interest is salary. Salaries vary considerably with the location. There are places in South America where living conditions are as agreeable as they are in the United States, and in such localities the American engineer finds himself competing with French and German engineers, with the result that wages are not materially higher than at home. However, in the more unsettled parts where large development work in mining and railroading is being carried on by English or American capital, salaries are considerably higher.

One important difference between the United States and South America which should be noted is that, while in the United States the engineer can always find something to do, in South America positions are only plentiful when some big development work is under way. It seems doubtful, therefore, whether an engineer with no knowledge of Spanish should go to these countries with nothing definite in view. He should be accurately informed concerning conditions.

From a standpoint of technical experience, it is doubtful if a sojourn in South America can be justified. The conditions under which much of the work is done are so different from what they are at home that the experience has little practical value to one who intends to return to the United States.

Chance To Become Cosmopolitan

Perhaps the greatest advantage of a trip to South America is the nontechnical experience. To a young man just out of school the trip serves as a post-graduate course with a peculiar value that could not be obtained from school training. He will meet on the work with men of every important nationality, from whom he can gain many new ideas—even a new way of thinking, inasmuch as Americans are so well insulated from the rest of the world that they are prone to think that nothing that is not American is of importance.

The considerations of salary and of experience are to most young men the matters of greatest importance. There is, however, another consideration that should be weighed. A trip to South America, to be made profitable, must be of from three to five years' duration, and every young man should stop to think what effect these years will have on his life—what they will do to his character and ambition.

The young man who goes to the more unsettled parts finds himself thrown suddenly into an environment so different that it cannot be adequately described. He is in a foreign country in a little settlement of his own countrymen. The refining influence of home has been taken away, and in its stead is the influence of a reckless, care-free life—a life that is monotonous and that tends to kill ambition. In short, the environment is a terrific strain on a man's character, and it is conservative to say that the majority of men who go to such localities are ruined.

May Lose Out at Home in Five Years

Assuming that a man is of sufficiently strong character to live without compromising with his attitude toward life, there is yet another consideration to be borne in mind. Three to five years of such environment must leave some mark on a man. Assume that he goes through it all successfully and comes home with a substantial saving, what is the result? The man arrives in the United States and immediately finds he is a misfit. He has grown away from his old friends—yes, even from his own folk. He has little in common with anyone. He looks for a position and finds he must start more or less at the bottom. Accustomed as he is to a higher salary, he is likely to find the prospects unbearable, and he packs his steamer trunk and journeys southward again. He has unwittingly made himself an exile.

"Is it worth while?" This question every man must decide for himself. Latin America is a land of opportunity for some. Experience and money may be gained, some characters may be strengthened, some will be ruined. But whatever may come to pass, no one can escape the stamp that the three to five years impress on his life: either he will find himself a voluntary exile or he must undergo the unpleasant and trying experience of "beating back."

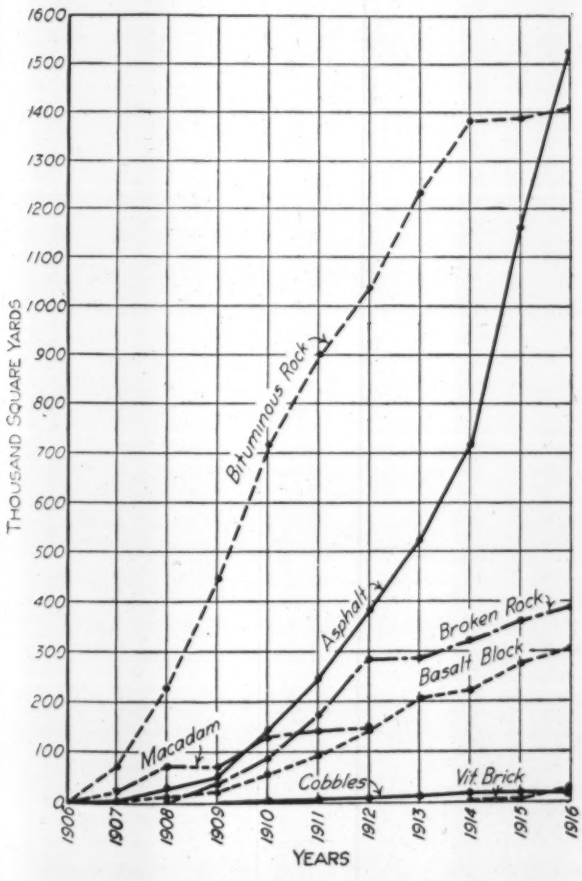
New Pavement Ordinance Helps San Francisco's Development

Small Yearly Payments Make Possible the Use of More Permanent Types—Checker-Board Streets Eliminated

By JAMES M. OWENS
Assistant City Engineer in Charge of Pavement Design

TO THE small-property owner it is a matter of vital importance whether his particular street improvement has to be paid for in 30 days or whether he has the alternative of paying for it in 10 annual installments plus a nominal interest. Under this latter plan of assessment many suburban and urban street improvements have been made in San Francisco that would have been impossible under the old law. The old law for doing assessment work was entirely inadequate, prescribing that "no assessment shall be levied upon any property, which together with all assessments for street improvement that may have levied upon the same property during the year next preceding, will amount to a sum greater than 50% of the value at which said property was assessed, exclusive of improvements thereon, except, however, as in this ordinance hereinafter provided."

During the life of the above law the hit-and-miss type of private contract, with all its irregularities, thrived. Since lack of proper street improvements is partly responsible for low land values in any given district, many natural residence tracts were retarded in their development on account of the existence of such a street-improvement act.



AMOUNTS OF PAVEMENT CONSTRUCTED IN SAN FRANCISCO IN 10 YEARS

New Law Speeds Up Improvements

The extraordinary increase under the new street-improvement ordinance that became a law in 1913 is due to the incorporating of the yearly-installment clause therein. Under the new law it is practically mandatory for the Board of Public Works to specify the installment plan in the handling of all such cases where 50% of the assessed value is to be exceeded. A review of the paving statistics of San Francisco for the last four years brings out this point strongly:

Year	Pavements Constructed, Sq. Ft. Private Contract	Public Assessment	% of Total Private	% of Total Public
1912–13	2,981,023	87,848	97 14	2 86
1913–14	2,994,094	374,358	88 89	11 11
1914–15	2,705,768	907,310	74 89	25 11
1915–16	2,237,258	1,504,434	59 73	40 27

The gradual passing of the private-contract method of doing street work is apparent from these figures, and it seems evident that the public-assessment plan will in time entirely supplant it. A more open and a healthier competition among the contractors will result, with the consequent lowering in the cost of work to the property owners. This works to the advantage of both the municipality and the property owners. It eliminates the dissatisfying and pernicious system of rebates only possible under the old form of private contract. It insures the contractor his money or its equivalent, but its greatest achievement is that of affording an opportunity of making the improvement in its entirety and not piecemeal—the last an inevitable result of the private-contract plan.

No longer can an unreasonable and reactionary property owner retard a necessary improvement desired by all his neighbors. True, under the old law he eventually could have been forced to have the work done, but during the interim the new improvement suffered and the entire traveling public was inconvenienced by his obstinacy.

Paving Quality Improved

Another betterment under this new law is that permanent improvements can be made immediately, instead of having to resort to cheaper types on account of the high first cost and the necessity for immediate payment. The curves show graphically the amounts of the different kinds of pavement constructed in San Francisco during the past 10 years. The initial years of the new law show the passing of the macadam pavement, a gradual diminution of the amount of broken-rock pavement and a very large increase in the amount of asphalt and vitrified-brick pavements—types mostly used in the residential districts. Perhaps if this new law had existed 15 or 20 years ago, a large percentage of the unsatisfactory waterbound macadam pavements would never have been constructed. The cost of that evanescent type of city pavement would have been saved to the property owner, who has had to add, in the majority of cases, the cost of a permanent pavement to his steadily increasing burdens. A further economic loss resulted; for had the permanent pavement been constructed in the first place, the municipality would have had to accept it and maintain it thereafter, whereas the upkeep of the unstable macadam pavement was charged to the property owner.

Experience has shown that first-class building improvements generally follow first-class street improvements. Nearly all the best residential tracts that have been developed during the last four years in this city offer proof of this statement, and probably at no other period in the city's history have so many special street-improvement projects been completed. On account of a prohibitive cost, these improvements would have been practically impossible under the old law, but were made possible of achievement by an advantageous clause in the new law, which allows the city the option of standing half the cost of the improvement when it is of more than local benefit or is clearly beyond the means of the district benefited.

Property Owners Appreciate Advantages

That the installment plan of paying for street improvement has met with the hearty approval of the taxpayer has been shown by the remarkable increase in the number of public contracts entered into annually. That he has benefited financially by this method of competition is shown by the following unit prices for asphalt, which has been selected as an example since it is by far the most predominant type of pavement in use in San Francisco.

COST PER SQUARE YARD

Year	Private Contract	Public Assessment
1912–13	$2 303	$2 356
1913–14	2 174	1 917
1914–15	2 202	2 052
1915–16	2 223	1 787

The successful carrying out of the new street law and the remarkable progress that has been made under it are due mainly to the efforts of M. M. O'Shaughnessy, city engineer, under whose supervision all such work comes.

Road Built on Foundation of Ice

Last summer the Board of Road Commissioners for Alaska found it necessary to build a road 5 miles long on a hillside. At one point the operations of a hydraulic mining company showed that the material underlying the location consisted of 6 ft. of gravel on the bedrock, 40 ft. of clear ice on the gravel and 2 ft. of moss and tundra on top. The only practicable construction for this locality was to cover the roadbed with willow corduroy, and surface the corduroy with gravel.

No Nuisance from Sewage Works Near Populous District

Imhoff Tanks and Contact Beds at Cheektowaga, N. Y., Operated Without Complaint for Two Years

CONFRONTED with the long-continued nuisances due to lack of sewers and pressed to action by the State Department of Health, the town of Cheektowaga, N. Y., a place of 10,000 population adjoining Buffalo, built sewers and met the problem of sewage disposal in a populous district by installing Imhoff tanks and contact beds. The plant has been in operation for more than two years with no complaint of odors from it.

The only available site for the disposal plant seemed to be at a point on Cayuga Creek adjacent to Clinton St., one of the main thoroughfares leading into Buffalo, 4000 ft. east of the city line. A number of buildings are located within a few hundred feet of the plant, which consists of two Imhoff tanks 14 x 66 ft. in plan by 14 ft. deep, four contact beds, 26⅔ x 90 ft. in plan by 5 ft. deep, dosing tanks and a 50 x 60-ft. sludge-drying bed.

ALTHOUGH LOCATED NEAR DWELLINGS, THIS SEWAGE PLANT, OF IMHOFF TANKS AND CONTACT BEDS, CAUSED NO COMPLAINT BECAUSE OF ODOR

Contact beds were used instead of sprinkling filters, because of lack of head for the latter installation and to minimize odors and the fly nuisance as much as possible.

Back-Water Traps Provided

The effluent from the contact beds and from the sludge-drying beds is discharged into the creek at Elev. 4.50. High water is at Elev. 14.50, which necessitates pumping the sewage from the effluent channel to the creek at times of high water. Back-water traps are provided in the pipes leading from the contact beds and the sludge bed to the creek, to hold out the creek water while pumping the effluent during high-water periods. Only twice since the plant was placed in operation has it been necessary to pump the sewage, as the high-water periods are of very short duration.

The sewers and sewage works were designed and built by George C. Diehl, Buffalo, N. Y., as engineer. The sewerage system cost $62,000, and the sewage works cost $56,000, or a total of $118,000.

How To Lay Out Fieldwork and Keep Office Records on Earth-Dam Construction

Phelps Brook Dam on New Hartford Water-Supply Used as Example of Field and Office Details of Construction on Similar Work

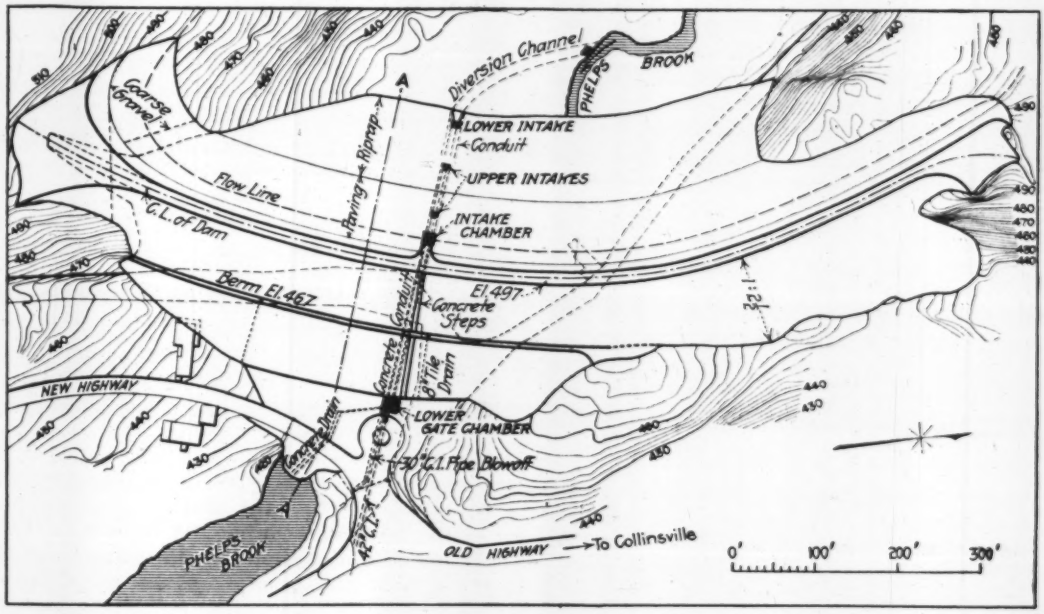
By SELDEN P. SEARS
Assistant Engineer, Hartford Water-Works

METHODS of laying out a large earth dam and of keeping office records of its construction, as worked out on the Phelps Brook dam of the new water-supply for the City of Hartford, Conn., were found most practicable. These methods, together with some minor adaptations since applied to other dams in the same project, are given below for the information of those who may find them useful on similar work.

The general layout of the dam is given in Fig. 1. Its dimensions are as follows: Maximum length, 1200 ft.; height above brook, 68 ft.; top width, 15 ft.; upstream slopes, 1 on 3 to flow line, 1 on 2 above; downstream slopes, 1 on 2½, with 4-ft. berm midway; maximum height of corewall, 86 ft.; maximum width of corewall, 8 ft.; minimum width of corewall, 2 ft. It is built on a compound curve, with centers upstream and radii 600 and 1400 ft. The arc formed by the 600-ft. radius is located between two of the 1400-ft. variety. This layout was selected in order that the cutoff wall might follow more closely the higher rock strata, which lie, on this line, a maximum of 32 ft. and an average of only 5 ft. below the surface, rock outcrops appearing over about half the length.

Laying Out the Curves

In laying out the curves for the outside limits of the dam the following methods were used: First, the center of the 600-ft. radius was determined in the field and the two P. C. C.'s where this curve joined the 1400-ft. radius on the center line of the dam were well marked. Two offsets, one on each radial line, were marked on each toe of the dam just outside the limits of the work. These points were augmented by others as the work progressed. All lines for grades along the dam were run from one of these points by using a common set of deflection angles figured for the center line of the dam and correcting the



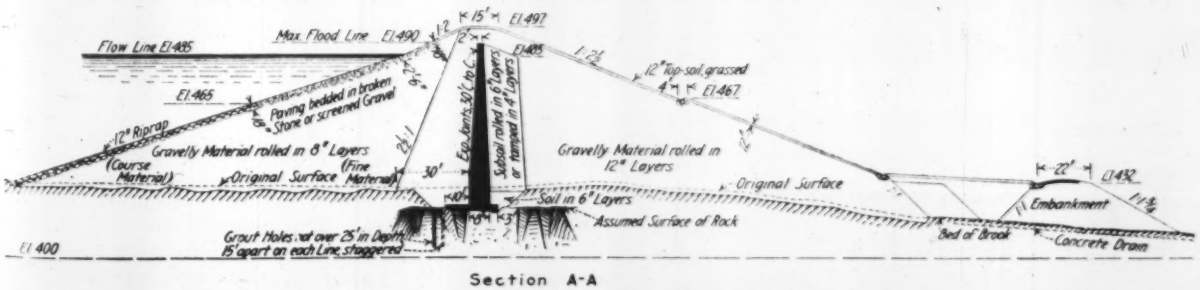
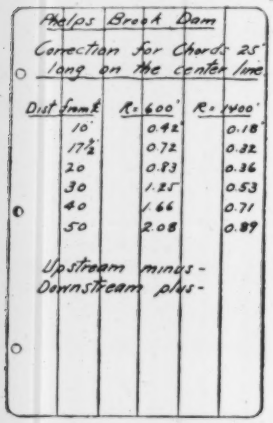

Flow Line El. 485
Max. Flood Line El. 490
El. 497
El. 485
El. 467
El. 465
12" Top-soil grassed
Paving bedded in broken Stone or screened Gravel
12" Riprap (Course Material)
Gravelly Material rolled in 6" Layers
Original Surface (Fine Material)
Excavation 30' to C.L.
Subsoil rolled in 6" Layers or hamped in 4" Layers
Gravelly Material rolled in 12" Layers
Original Surface
Soil in 6" Layers
Assumed Surface of Rock
Embankment
Bed of Brook
Concrete Drain
El. 400
Grout Holes set over 25' in Depth 15' apart on each Line, staggered
Section A-A

FIG. 1. LAYOUT AND CROSS-SECTION OF PHELPS BROOK EARTH DAM FOR HARTFORD WATER-WORKS

25-ft. chord length by using a table similar to the one shown in Fig. 2, for the distance from the center line at which the grades were needed. Grades were given approximately every 10 ft. horizontal, on both sides of the dam.

In all the fieldwork loose-leaf notebooks were used and the notes filed in the office under the various items, numbered as they appeared on the contract, where possible. In case one set of notes covered more than one item, as where final rock contours would be also the limit of rock excavation and of concrete masonry, sheets could be filed under either item and a cross-reference made to the other. File and reference numbers should always be written on each sheet before it is filed.

All office computations were made on 8½ x 11-in. loose-leaf sheets ruled faint blue four to the inch both ways. These sheets were filed in regular book covers under item numbers entirely, with the exception that sheets having no special connection to any item were filed in the front of the book, preceded by an index. Projecting strips of cardboard containing the item number were pasted on the first sheet for each item, to form a thumb index. On this same sheet were pasted extracts cut from the specifications dealing with the special methods of payment for that item; also any special information, such as total estimated amount, contract price or, in the case of steel reinforcement for example, the weight per foot of the various sizes called for, were written in.


Phelps Brook Dam

Correction for Chords 25' long on the center line

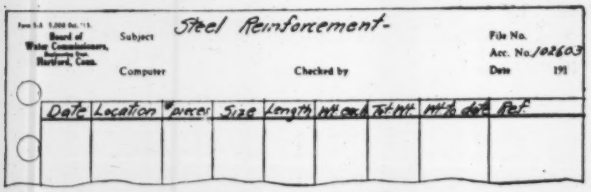
Dist from ℄	R = 600'	R = 1400'
10'	0.42'	0.18'
17½'	0.72	0.32
20	0.83	0.36
30	1.25	0.53
40	1.66	0.71
50	2.08	0.89

Upstream minus - Downstream plus -

FIG. 2. NOTEBOOK PAGE FOR EARTH DAM LAYOUT; ORIGINAL IS 4¼ x 3 IN.

All sheets were given a file number composed as follows: First two numbers equal number of the contract; second two, number of the item; and all others, the page under that item. For example, 07183 means contract 7, item 18, page 3. For items for which no definite or final amount could be determined for each estimate, summary sheets 17 x 11 in. were used and numbered with an extra zero before the page number. Where an item had several subdivisions, letters were used; for instance, cement had two divisions, "Cement Used" and "Cement Received." As "Cement Used" is what is paid for and therefore the principal item, it was given no letter, but "Cement Received" was distinguished by 1022A5—contract 10, item 22A, sheet 5.

Where exact amounts under any item could be finally determined in each day's work, they were tabulated substantially as shown in Fig. 3, the amounts being taken from the inspector's daily report, Fig. 4. The reverse side of these report sheets is ruled horizontally four lines to the inch, for recording any further details of the day's work.


Board of Water Commissioners, Hartford, Conn.

Subject: Steel Reinforcement-

File No. Acc. No. 102603

Computer: Checked by: Date: 191

Date	Location	Piece	Size	Length	Wt. each	Tot. Wt.	Wt. lb. det.	Ref.

FIG. 3. OFFICE RECORD OF STEEL USED IN COREWALL; ORIGINAL IS 8½ x 11 IN.

Rectangular Coördinates for Field Layout

All the cross-sections taken on the work were on a rectangular coördinate basis; but in general, cross-sections were used only for earth sections outside the corewall

Form 66 Mar. '16

ENGINEERING DEPARTMENT

BOARD OF WATER COMMISSIONERS

HARTFORD, CONN.

DAILY REPORT OF WORK AND MATERIAL

East Branch Division 191

ITEMS	DESCRIPTION	UNIT	EXACT QUANTITIES	APPROX. QUANTITIES
1	Clearing and grubbing	acres		
2	Earth excavation below El. 360	c. y.		
3	Earth excavation not in Item 2	"		
4	Rock excavation for core-wall	"		
5	Rock excavation not in Item 4	"		
6	Special preparation of rock surfaces	sq. y.		
7	Refilling and embanking	c. y.		
8	Refilling and embanking	"		
9	Refilling and embanking	"		
10	Surface dressing and grassing	"		
15	Finishing concrete surfaces	sq. ft.		
16	Brick masonry	c. y.		
18	Making connections			
19	Grout	c. y.		
20	Drilling holes in rock	lin. ft.		
22	Paving and dry rubble masonry	c. y.		
23	Riprap	"		
24	Furnishing and laying c. i. pipe	tons		
25	Small steel pipe	lbs.		
26	Metal for reinforcing	"		
27	Miscellaneous c. i., w. i. and steel	"		
28	Bronze and copper	"		
30	Vitrified pipe, 8" or less	lin. ft.		
31	Vitrified pipe, 10" to 15"	" "		
32	Gravel surface for highways	sq. y.		
33	Wooden guard rails	lin. ft.		
35	Gravel and broken stone	c. y.		
36	Test borings	lin. ft.		
37	Extra work			

Remarks

Inspector

FIG. 4. FACSIMILE OF DAILY REPORT OF MATERIAL; ORIGINAL IS 5 x 7¾ IN.

limits. As soon as the contract was let, the original earth sections were plotted for each 25 ft., across the dam, on 16 x 20-in. sheets, ruled 10 to the inch both ways, using the scales—Horiz. 1 in. = 25 ft., Vert. 1 in. = 5 ft. On these the notes for each estimate were plotted. The outside lines of the dam, for measuring embankment, were plotted on these sheets by using the formula $a^2 + b^2 = r^2$ and computing the critical points, such as berms, changes in slope and other intermediate points most needed where the skew of the section is greater than 20° to a normal section of the dam.

In the formula, knowing the slope of the dam, the radius is easily determined by the elevation at which a point is desired; and one coördinate, that of the section selected, is always known. The form for this computation is shown in Fig. 5. It was gratifying to note that the final cross-sections, taken as the rectangular coördinate basis, checked the sections thus computed. By using this method in figuring the earthwork no correction for curvature was necessary.

Progressive Steps in Building Corewall

The general methods of fieldwork along the corewall trench were as follows: Drill holes in the rock, at each expansion joint in the corewall, which were placed 30 ft. c. to c. Drive a wooden plug into each hole and center the plug with a small nail. The stations of all these

points were figured on a coördinate basis from a tie-up at each end of the dam. The critical points on the original and, later on, the excavated rock and the concrete aprons were located from a set-up over one of these points by deriving the H. I. from the nearest B. M., reading azimuth, level rod and horizontal distance if the same could be readily plumbed, or skew distance and vertical angle where the point taken was below the rod limit or above the H. I. By using a 100-ft. tape this method gives a good range in both the vertical and horizontal and quickens the fieldwork, which is an important item when working amid an assortment of machinery and adverse physical conditions of mud, steam and blowing sand.

The notes as taken by the foregoing method were reduced in the office by the slide rule and plotted for a contour map, scale 1 in. = 5 ft., the original rock on one sheet and the excavated or final rock and concrete on another. The different elevations of the concrete aprons were inked in different colors with the elevation marked in the center in the same color. The volume of rock was then figured by planimetering the contours on each sheet. Concrete was figured in the same way up to a point where it could be resolved into a regular geometric figure. A check on the amount of concrete placed was obtained from the mix and amount of cement used, as shown on the cards made out each day by the inspector, a copy of which, designed by the writer, is reproduced properly filled out in Fig. 7.

In these blanks, "Card number" refers to serial number, "Ref. card number" to cards recording any previous work on this section, "Section" to the location of the work (generally all work between two successive expansion joints is given a letter for designation). Under "Remarks" may be written any special notes about the work, or materials incorporated in the work may be here listed.

A record of the amount of cement used each day is transferred from these cards to one of the 8½ x 11-in. sheets with the simple tabulation: "Card No.," "Bags used," "Bags used to date," "Bbl. used to date," "Remarks." A record of the concrete placed in each section is kept on the form shown in Fig. 6. After computations are made to an elevation that will include all the aprons and inequalities, the amount of concrete above this elevation is figured directly from the cement cards and placed on the sheet, Fig. 6. The primary object of these sheets is to avoid the duplication or omission of a lift in a section. For each estimate the total cubic yards to date for each section is transferred to a summary sheet.

Board of Water Commissioners, Hartford, Conn. Subject: Ahelps Brook Dam - Coördinates of points on the downstream slope - finished grade - Computer: Checked by: File No. Acc. No. 64-4 Date 4-17 1916

Coordinates of center 'B' = 380 ROP = 380-1801

	Radius →	1400	1407.5	1450	1482.5	
	POB →	1,960,000	1,981,056	2,102,500	2,197,806	
	Elevation →	E-497.0	497.0	480.	467	
Section	a	a^2	b^2	b^2	b^2	b^2
13+25	945	893.025	G 76	G 65	G 08	F 66
+50	970	940,900	G 99	G 88	G 81	F 87
+75	995	990.025	H 23	H 12	G 53	G 09
14+00	1020	1,040,400	H 49	H 38	G 77	G 33
+25	1045	1,092,025	H 77	H 65	H 03	G 56

FIG. 5. HOW THE COÖRDINATES FOR CURVES IN DAM ALIGNMENT ARE FIGURED

Board of Water Commissioners, Hartford, Conn. Subject: Concrete Class A - Sect. O-P File No. Acc. No. 10/147 Computer: Checked by: Date 1918

Section O - Stations +556 to 44+85.9 = 302'

Ref. Card	Ref. Sheet	Height	Elevation	Cu. Yds.	Cu. Yds. to date	Remarks
110, 111	8		339.0	142.7	1 4 2.7	Includes apron.
115		13.5	352.5	120.8	2 6 3.5	

FIG. 6. RECORD OF AMOUNT OF CONCRETE USED; ORIGINAL IS 8½ x 11 IN.

Engineering Department
BOARD OF WATER COMMISSIONERS
HARTFORD, CONN.

DAILY RECORD OF CEMENT USED

Contract # 10 Nov. 9 1916
Card # 115 Ref. Card Nos. 110, 111

Where used Corewall — Concrete Class A
Sect. O — Elev. Top 352.5 — Approx. 34 C. y.
Height of Section 13.5' — Comp. C. y.
Time started 1 A.M. 2:30 P.M. — 3.2 | 34
Time stopped 1 A.M. 5:40 P.M.
Hrs. worked 3⅓ C. y. per hr. — 10.6

153 BAGS USED today from Car # 229501

		Mixture	Bags
0	Bags rec'd on Car #		
0	Bags returned from platform.	1-0	3
3807	Bags in shed (Previous Card)	1-3	6
+ 0	on platform.	1-3-6	144
- 155	<> 155 taken from shed.		
	155 Total	Used-	153
- 155	Used, sold and wasted.	Sold-	0
3652 + 0	Amount on hand.	Wasted-	2
3652	" " "	Total-	155

Remarks: Used 6' of 8" x ¾" Ingot Iron.

Q.E.D. Inspector.

FIG. 7. FACSIMILE OF DAILY RECORD OF CEMENT; ORIGINAL IS 5 x 7¾ IN.

In conclusion, the writer would suggest that in many cases it might be more convenient to use rectangular coördinates throughout for rock excavation and concrete, but in this case it seemed hardly feasible to maintain two sets of points along or near the center line; and unless sections were taken every 2 or 3 ft., several interpolations would be necessary to include properly all the steps in the concrete aprons. Some 30-ft. sections formed as many as five different elevations, owing to the rough character of the rock.

Give Costs of Dredging Irrigating Ditches

Working on 75 miles of canals, three dredging machines excavated 310,329 cu.yd. of material from the irrigating ditches of the Imperial Water Co., California, in 1916, at a cost of 9.59c. per yd., as compared with 9.52c. for the preceding year. A No. 110 Stockton dredge removed 112,674 cu.yd. at 10.61c. per yd.; a No. 117 Stockton removed 155,360 yd. at 8.86c., and a Schlatter dredge moved 42,295 cu.yd. at 9.54c.

In the performance of this work the two first-named dredges in moving from one canal to the other traveled 135½ miles at an average cost of $6.08 per mile, as compared with $6.72 for the previous year. Repairs cost $69.20 per dredge-month, as compared with $30.35 for the preceding year.

Two 60-Horsepower Gas Tractors Build Dirt Road for $60 a Mile

On the Longer Tangents Some Sections Were Graded at a Cost of $30 per Mile —Maintenance Is Simple

By E. R. MORGAN

State Road Engineer, Salt Lake City, Utah

THE construction of about 100 miles of dirt road over virgin soil at an average rate of 1¼ miles per day was made possible by using two Mogul gasoline tractors pulling two road graders. A cross-section 24 ft. wide from ditch to ditch, with a 9-in. crown, was adhered to almost entirely, the width of the road being increased, however, to 30 ft. through towns and settlements.

The progress of the grader and traction work on the longer tangents of the road amounted to an average of 1¼ miles per 10-hour day. The cost of the outfit being

HEAVY CUT MADE QUICKLY BY POWERFUL TRACTORS

$75 per day, the unit cost was $60 per mile. The record day's run made on this project was 2½ miles per day. This amounted to only $30 per mile of road, surpassing all previous state records for speed and economy of road construction. Surveying, clearing right-of-way, plowing and finishing, however, amounted to considerable, many stretches requiring team and hand construction. The average cost of the 100 mile of road was $275 per mile, not including bridges and culverts.

A broad reconnoissance of this road was made originally by automobile, followed by a rough preliminary survey that was made with compass and hand level aided by the existing Government survey. The final location shortly preceded the construction of the road, allowing the locating engineer to inspect the construction at reasonable intervals. In general, the location was along township and section lines in surveyed regions, but was allowed to meander along foothills through unreclaimed land.

The road extends southwestward from Snowville to intersect the Nevada line just west of Lucin, passes through a sage-brush country, mainly virgin soil, and encircles the north end of Great Salt Lake in Box Elder County.

Since this road was constructed, it has been maintained in the following manner: Each spring a complete grading of the road is made with a horse-drawn grader. The grader travels the full length of the road and back again, the work being done immediately after the breaking [up] winter, while the ground is still damp. These conditions make the work of the grader most efficient.

In addition to this operation, the road is dragged after each rain. This results in a very smooth and lasting surface and seems to produce a certain toughness or increased cohesion in the material. In drying out, the soil cements in such a fashion that it does not crack from the heat of the sun.

The work was done under direction of the State Road Commission of Utah, $15,000 being appropriated from the state treasury and $12,500 being supplied from the state road fund of Box Elder County.

Contractor's Damage Suit Charges Engineer with False Statements

O'Rourke Company Names William M. Brown in Million Dollar Damage Suit on Passaic Valley Sewer Contract

THE complaint filed in a suit brought by the O'Rourke Engineering Construction Co., of New York, against the Passaic Valley Sewerage Commissioners of New Jersey, for damages amounting to nearly a million dollars, brings serious charges against the commissioners and against William Maxwell Brown, chief engineer to the commissioners. It accuses both the commission and Mr. Brown of falst statements made "fraudulently and deceitfully." It is claimed that they deliberately misled the contractor with respect to the nature of a difficult and costly tunneling job, in order to secure a low bid.

The contract in question was for Section 2 of the Passaic Valley outfall sewer, extending from a point just east of Newark Bay in Jersey City, N. J., easterly for 5000 ft. to the shore of New York Bay and thence about 10,000 ft. under New York Bay. Two shafts were involved in the contract, but payment was to be made per running foot of tunnel. Borings were made by the commission to show the character of the material, but the complaint in the suit alleges that cores from other borings were substituted for the findings of these particular borings.

Compressed-Air Tunnel Bids Rejected

The history of the contract has an unusual complication in that two successive advertisements for bids were made. The first was made about the middle of 1913, and the bidders were left free to choose the method of working. The bids were based on pneumatic tunneling and ranged around $2,500,000. These bids were rejected by the commission.

Soon afterward, in January, 1914, a second invitation for bids was issued, but this time it was specified that only free-air methods of tunneling were to be employed. Just five weeks were given, to the time when bids were to be opened.

Drawings were furnished with the call for bids. They showed the strata to be traversed by the tunnel and indicated the location of 16 borings said to have been made by the commission along or near the line of the tunnel. The profile was alleged to be the result of information obtained by the borings. It purported to show that most of the tunnel would pass through a material called "co-

mented triassic formation"; a small part of the tunnel would go through Hudson schist. A cross-section of the tunnel was shown at one point where, according to the profile, the material surrounding was "cemented triassic formation," and this section by conventional symbols indicated the material as rock.

Boring Results Questioned

But to confirm the information so given, the contractor interviewed the chief engineer of the commission who made statements concerning the nature of the material, which were in agreement with the drawings. He stated that the drawings, based on 16 borings made 50 to 100 ft. south of the tunnel location, "truly showed the kind and character of the material taken from the different borings" (we quote from the complaint).

In addition, Mr. Brown showed a sample of triassic rock "which he stated had been taken from one of the borings beneath said New York Bay shown on said drawings, and also then stated that said sample was of the same kind and character of material as that taken from other borings made under said bay and salt marsh, as shown on said drawings, and also then stated that said sample was the only one of the kind which had been preserved; and he then further stated that water had been allowed to run on said sample, as soon as it was taken ashore, for 24 hours, without any apparent erosion or disintegration, and stated that said sample was the cemented triassic formation referred to by him and referred to in said drawings."

The Fraud Charge

The charges of deliberate misrepresentation are then stated in the following paragraph:

"Plaintiff avers . . . that the material through which the said tunnel was to be constructed . . . a distance of about 11,000 ft., was not cemented triassic formation; that the said drawings did not truly show or state the kind and character of said material; . . . that the material . . . was not in fact cemented triassic formation; and that in fact no cemented triassic formation was found or encountered in said borings; that the said sample of cemented triassic formation which said chief engineer exhibited . . . had not in fact been taken from any borings shown in said drawings or from any borings made in said bay and that said sample was not in fact in any wise similar to the material which was actually taken from said borings. . . . Plaintiff avers that the said material through which . . . the tunnel . . . was to be constructed . . . was in fact disintegrated mica schist and soft clay, sand and gravel formation, and that said last-named materials were in fact the materials which were actually existing and actually taken from all of the said borings. . . .

"Plaintiff further avers that when said chief engineer made said several statements and representations . . . the said chief engineer and said defendants knew that said statements and representations and each and every one of them were untrue, and that said chief engineer made the same under the direction, authority, and with the approval of said defendants which knew that the same were made and that said chief engineer and defendants, falsely, fraudulently, and deceitfully made said statements and representations for the purpose of deceiving and defrauding the plaintiff and inducing the plaintiff to bid and make said contract at a price for which the same could not be performed without great loss to the plaintiff."

Contractor Encounters Difficulties

The O'Rourke Engineering Construction Co. bid about $2,000,000 on the basis of this information and, being lower than the next bidder, was awarded the contract and began work. The work proved disappointing, but Mr. Brown is charged with having continued to lead the contractor on:

"When said plaintiff found that the material at said easterly heading of said land shaft, and at both of said headings of said bay shaft, was such as is hereinbefore described, the said chief engineer again stated and represented to said president and agents of said plaintiff that the difference between the materials so found at said last-named places and that found where said borings were made as aforesaid, was due to the fact that the excavation then so far made for said tunnel had encountered intervening pockets or areas which were small and limited, but that if plaintiff would proceed with said tunnel it would in a short distance reach the cemented triassic formation . . .; and said chief engineer again represented to, and assured the president and agents of said plaintiff of the truth of all of the statements and representations hereinbefore set forth, and requested said plaintiff to proceed."

The plaintiff claims that because of the short time and the winter season he could not make borings of his own or otherwise endeavor to check up the specific information given by the chief engineer of the Passaic Valley Sewerage Commissioners. Relying upon those statements, he undertook the construction of the tunnel and in a short time found that conditions were quite different from those represented. Soft running ground was encountered, through which it was impossible to construct a tunnel by free air and in which even compressed-air work was difficult and could only be carried on at very high pressure, hence at very high cost.

Agreement for Extra Compensation

After proceeding with free-air work for some time, a special agreement was entered into by which the commissioners gave the contractor extra compensation for carrying on a short length of compressed-air tunnel from each shaft. When the stipulated compressed-air length had been completed and the material had not improved, work was suspended, in the spring of 1916, just two years after the contract was signed.

The loss which the contractor suffered, due to the departure of the material encountered from that described and represented in advance and due to the peculiar method of payment and to his large investment in plant, forms the major portion of the damage claim.

A peculiar feature of the contract complicated the situation. The contract provided that if so much water was encountered that free-air tunneling proved impracticable, in the opinion of the chief engineer, then, upon his certifying accordingly, the contractor might abandon the contract without incurring penalty or damages.

This provision also made trouble. When soft ground made further free-air work impossible, it is said that the water certificate was not forthcoming. It was actually issued some time after the contractor had stopped work.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

How Contractors Can Serve the Country

THE Government in the present emergency can make use of and will need the plants, organizations and resources of many of the country's contracting firms. The vital services for which such concerns are fitted are many. For example, a Canadian contractor and his organization are reported to be making a splendid record in handling all the narrow-gage transportation construction and maintenance behind the British front in France. Of the American firms which have already volunteered their services for the Government, one is carrying out rush construction at two points on the Atlantic Seaboard for the U. S. Navy, and is preparing to construct its share of our proposed wooden merchant marine, while another is preparing to break all building construction records in erecting storehouses for the Navy.

Aside from members of the General Contractors' Association, and a few other Eastern firms, who have already volunteered their services and given the Government an inventory of their resources, Washington is still ignorant of the location and capabilities of the contracting firms of the country. Much work must be done, and done promptly, which can be carried out better by contractors with their present organizations than by specially organized army divisions which would have to rob the ranks of these companies to recruit their forces. Moreover, many contractors are now engaged in work which is vital to the conduct of the war, and which should not, under any circumstances, be halted by the volunteering or drafting of their men for army services, or by the possible requisitioning of their resources on the part of the Government for some other work. The *Engineering News-Record* has been advised that contractors, even in the interior of the country, are already faced with the question of whether to try and retain their organizations or to encourage their men to enlist for engineer service.

The former course, it is certain, will prove more advantageous to the country in the long run, as one organization in smooth working trim is worth, on emergency construction work, a dozen whose personnel has been hastily scraped together. The Government, however, is not yet in a position to outline work for these contractors. In fact, work which in a few months may develop as vitally necessary, has not as yet loomed on the horizon.

To help the Government in this emergency, to relieve its overburdened departments of the necessary detail, and also to put all those contracting firms who are anxious to render patriotic service in line for the first work which develops, the *Engineering News-Record* takes the initiative in calling for a census of the resources of the contractors of the country. Particulars will be found on page 282 of the "News of the Week Section" of this issue.

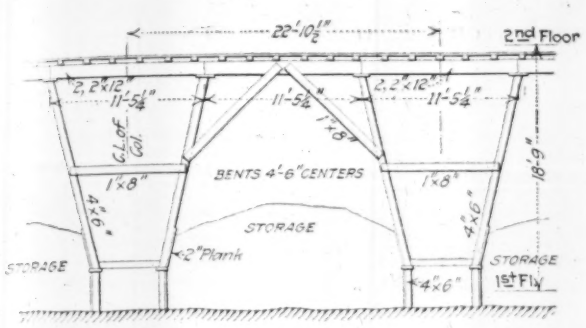
Let every patriotic contractor, who is not already in touch with the Federal Government, respond at once! This journal on its part promises that the information will reach the proper Federal authorities in useful form as rapidly as it can be classified.

Forms Designed To Give Storage Space Inside Building from Start of Work

By EARL J. WHEELER
Toronto, Ont.

THE SITE for the mail-order building of the Robert Simpson Co., of Toronto, Ont., did not afford storage space for sand and gravel; and as the street had to be kept open for traffic, storage for 1250 yd. was provided in the building by employing specially designed form supports. The use of bents with wide space between them for storage was made possible by unusual storyheight of the first floor—18 ft. 9 in.—and the fact that there was no basement. The bents were 11 ft. apart at the top

TWO BAYS WERE RESERVED FOR SAND, TWO FOR STONE AND ONE FOR CEMENT



WIDE SPACE BETWEEN BENTS FOR STORAGE

and 17 ft. apart at the bottom, this construction being carried over an area six bays wide and three bays deep. The fourth bay, in front of the aisles thus formed, served as a connecting passage, and bents were built lengthwise of it for the full width of the six bays. Teams would drive into any of the first five bays, dump and return to the street by way of the connecting passage and the sixth bay, which was used for return only.

Each storage space thus provided had a length of about 75 ft. and a width of 17 ft., giving a storage capacity of 250 yd. Two bays were reserved for sand, two for stone, and one for cement.

The bents, constructed as shown in the sketch, were made on the ground and were all alike. They were erected on 2-in. plank caps resting on short shores on blocking, the short shores being placed first and cut off to grade. The construction was very satisfactory and as economical as ordinary shoring.

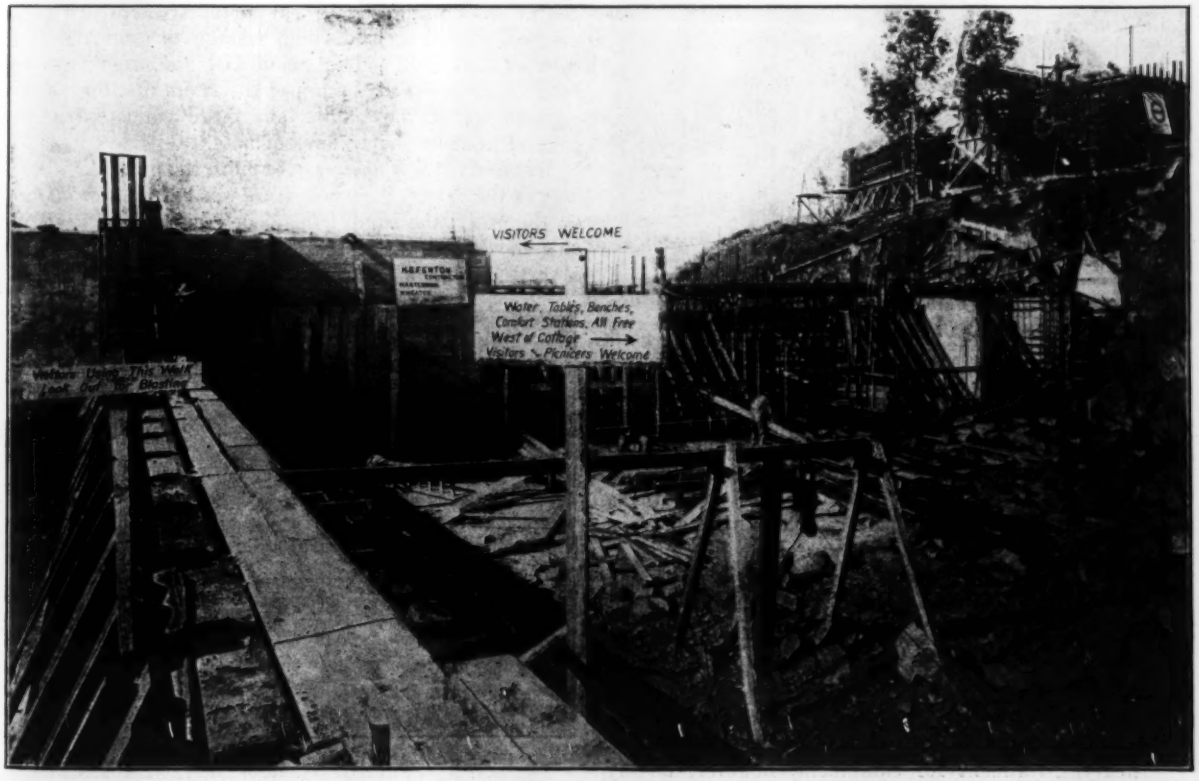
Wells Brothers Co. of Canada, Ltd., was contractor for the building, work on which was under the direction of J. Purves, resident manager for this firm.

"Visitors Welcome" Policy Pays on Sweetwater Dam Construction

THE ENLARGING of the spillway capacity at the Sweetwater dam, near San Diego, Calif., which has included the construction of a siphon-type spillway, has involved work of a character and magnitude that would naturally attract the interest of layman as well as engineer, particularly in the case of residents of the vicinity. H. N. Savage, consulting engineer in charge, adopted a policy of welcoming all visitors and allowing them the freedom of the work.

Signs were posted on all roads leading to the dam, giving direction and distance and bidding visitors welcome. The customary "Positively No Admittance" signs were all removed, and instead at the entrance gates there was posted a "Visitors Welcome" placard accompanied by directions for finding the engineer's office, picnic tables, drinking water, comfort stations, etc. Warnings about danger from blasting, going too near the edges of excavations, etc., were posted where necessary. The falsework had been solidly built, and the erection of inclosures around ladders and the addition of a handrail here and there were practically the only changes made as additional safeguards for visitors.

As a result of this policy, during the construction period a great number of visitors inspected the work nearly every day and went away with a definite idea of what was being done and how it was accomplished. In con-



SIGNS AT SWEETWATER DAM INVITE VISITORS AND TELL THEM HOW TO GET ABOUT OVER THE WORK

sequence, there is now a general impression that the work is adequate and of a substantial nature, particularly among residents of the valley below the dam, whose property would be endangered if an insecure structure were erected.

No accidents have been suffered by visitors, nor has any delay or inconvenience to workmen resulted from their presence on the work. Not infrequently visitors have expressed surprise at a policy so radically different from that usually in effect, and with the surprise has been a feeling that the company had nothing to conceal and was proud of the character of work being done.

Road Contractors' Chief Problem Was Haulage of Materials

A COMBINATION of long hauling distances for materials and numerous hillside slips made the wet weather prevailing during the construction of the national highway through Ohio a difficult matter for the contractor. Besides the shortage of labor and the difficulties of obtaining materials, there were many local circumstances that prolonged the work beyond the date set for completion. The State Highway Department was deeply concerned to know just how far it should go in compelling contractors to increase their forces and equipment, according to Robert N. Waid, division engineer, from whose paper before the Ohio Engineering Society the following is extracted:

The hauling of materials was by far the hardest problem for the contractors, and all four of the chief means were employed. About two-thirds of the materials required to construct the 90 miles of highway were delivered by teams, the remainder by industrial-railway trains, motor trucks and traction engines.

The traction-engine train, according to Mr. Waid, is perhaps the least adjustable to varying conditions. It appears best adapted to fairly level, straight roads, which have not been paved, and where the average haul is not less than one-half mile. The cost of hauling by this method proved to be about 24c. per ton-mile. Team hauling is too familiar to warrant special consideration; and although thousands of tons of material were hauled by this method, the results obtained disclose nothing new.

Motor-Truck Limitations

While no motor trucks were used where the average haul was less than 2 miles, hauling by this method was quite generally successful. Wet weather put them absolutely out of commission, however, and after thorough trial, trailer wagons were ultimately abandoned. The large 7-ton trucks, which were first tried, did not work as well as the lighter 3-ton truck; and several of the heavy trucks were exchanged for lighter ones. The cost per ton-mile, where the trucks were successful, was about 14 cents.

In the 24-mile concrete section west of Zanesville and on the 7-mile section west of Cambridge, a 3-ft. gage industrial railway was used to transport materials. The two chief troubles encountered consisted in operating over grades that exceeded 5% and in maintaining the track after it had been down all winter. The actual cost of operation and maintenance was about 11c. per ton-mile. The heavy investment for equipment, however, largely offset the low cost of operation, and for the contractor w does not expect to handle large contracts this metho hauling holds out no inducement.

The average cost to the several contractors for grad was approximately 40c. per cu.yd. All classes of ex vation for drainage structures cost on an average $1.15 cu.yd. Mixing and placing concrete in the small culver cost $1.60 per cu.yd. The cost of laying rubble ma sonry was $1.85 per cu.yd. The labor cost for buildi forms for the concrete culverts was $1.22 for each cub yard of concrete. The cost of placing the reinforcin steel in the drainage structures was 55c. per 100 pounds.

Pumps for Emptying Shaft Hung from Movable Overhead Truss

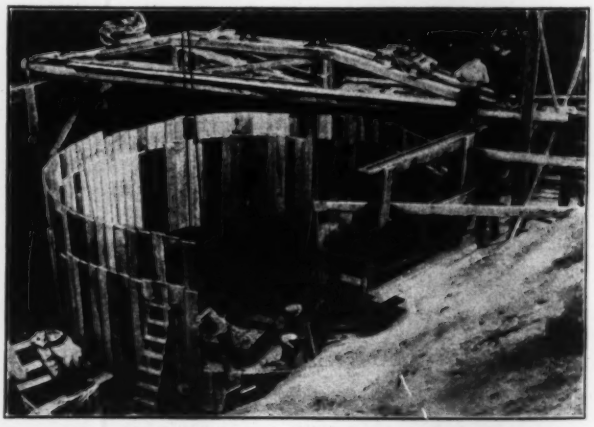
By R. E. POST

Superintendent of Construction, Keechelus Dam

IN the construction of the Keechelus dam for the United States Reclamation Service at North Yakima, Wash., the shaft for the tower foundation was sunk inside Wakefield sheet piling driven by a 4500-lb. steam hammer suspended from a derrick. The ground was firm sand and gravel carrying considerable water, which made it necessary to keep the pumps going steadily. The method of excavation was to dig and hoist material two shifts, leaving a sloping bench next the piling, and to excavate this bench and drive piling the third shift.

In driving the piling it was necessary to dig under each pile and follow with the driving. With this system the pile hammer made about two rounds of the circle in a shift. In order to provide a clear way for the driving, the pumps were suspended from a movable truss, as shown in the illustration. The winch, steam lines and discharge lines were all fastened to the truss, which rested on rails spiked to bents high enough to clear the 10-ft. pile sections used. The steam and discharge lines had long swing joints at the top of the risers to allow vertical adjustment of the pumps and were connected to the ground lines by short pieces of hose.

Whenever it was necessary to move the pumps out of the way of the driver, the whole truss was barred over one way or the other, the sump holes being dug oblong to permit this movement. The truss was inexpensive and proved a very convenient solution of the problem.



PUMPS SUSPENDED FROM MOVABLE TRUSS

EDITORIALS

With this issue of *Engineering News-Record*, Charles Whiting Baker retires from the position of Editor and becomes Consulting Editor. Frederick E. Schmitt, who has been Associate Editor of *Engineering News* since 1902, succeeds Mr. Baker as Editor.

We Will Get Down and Dig!

WE ARE going to get down and dig—we the nation and we the individuals. A small part of our number will dig in drillground and battlefield. A larger number will dig in the farm acres. For all these the duty, the compulsion, is plain. But the rest of us too must get down and dig! That is the great, strong fact which is more important, more compelling, yet less plain. The willing and the unwilling—those who have to dig and those who in comfort feel that they need not—all are going to get down and dig.

A race inhabiting a virgin country, dowered with boundless natural gifts, we have drifted and wasted along. And now necessity makes us husband the flour in the bin, deny ourselves a bit in potatoes and meat, look forward anxiously toward the next croptime, stir up vacant lots and plow the golf links. In the matter of cultivating the soil whence we draw our food, we have heard the call, a loud call, to get down and dig.

And so too in some other fields of production have we heard the call, though less vociferous. Scarcity is upon us; mounting prices throttle us. We are urged and compelled to retrench, to skimp. Whether it be in rare products of a foreign land, as platinum; or home products, as leather and shoes—even those in which we lead the world, as steel—the warning of deficient supply has told us of present danger and greater future dangers threatening. The call has been heard; the call to get down and dig, to produce more abundantly and to use more wisely.

But the same call is everywhere, in every field of production—for that matter in every field of work. It is universal. It addresses itself to the individual. It goes out to banker and to garment worker as well as to printer and to railroad man. Not to the banker as banker, nor to the railroad man as such, but to each as an individual, a working unit. The call is for every man to get down and dig—to dig for capacity and efficiency.

And we *will* dig. The fallow ground of easy and slipshod habit must and will be turned under.

We will dig to raise more corn per acre and more per man. We will dig to produce more useful transportation per railroad president and per brakeman. We will dig to produce more justice per court and more commerce and growth per banker, more and better power-generation and flood-protection per engineer, more good concrete per contractor. We will dig for more conscience and industry in every single man of us. We will dig the trenches for the battles that are to come.

But why say this to engineers? They stand ahead of all even now in efficient and conscientious labor!

Engineers are men first of all, and their first duties are the duties they share with all men. Because they stand in the van of efficient and high-capacity production the duty lies strongest upon them to lead the fight for the coming progress. For this leadership engineers must begin now to prepare. It is theirs.

Highway Work Should Not Stop

HIGHWAY construction is seriously threatened by present conditions. The chief engineer of the highway department of one of the important states in the Union expects that of nearly three hundred uncompleted contracts under his direction, involving $8,000,000 or more, half will result this summer in the bankruptcy of the contractors. Bids for new brick road construction are touching $3 a yard, the limit which this highway department feels it can pay in any circumstances. Two-dollar cement and fancy labor prices have made concrete roads a luxury. The state received but three bids at a recent letting in which its highway sections were advertised. Contractors can go no farther, and the chief engineer does not believe that the state will be able to carry on work even as cheaply as the contractors.

On some of these contracts, it is true, failures were only to be expected. Many inexperienced men, attracted by the quantity of work, rushed into the highway field in 1915 and 1916. They took work on estimates of the sort that ought to result in the discomfiture of any contractor. They prosecuted the work without adequate plant or organization, and could not be expected to bring it to a successful conclusion.

But it is also true that many competent contractors, delayed by bad weather, congested freight conditions, and an inadequate labor supply, have had work prolonged beyond the expiration of their agreements with the firms supplying them materials. And it has proved impossible for these men to protect themselves against price advances and the increasing cost of labor.

Neither the manufacturers of paving material nor the public can afford to let highway work come to a halt. The farmers must have better transportation, and the need for it was never more urgent. The brick, asphalt and cement manufacturers would scarcely care to shut off a market which furnishes a large share of their sales.

So much for the facts. The cause is not far to seek. Prices have gone up largely because the country has been flooded with money. Road materials cost more because the people who make them have been competing with more prosperous industries for labor, and everything required in the manufacturing processes has gone up with the general advancing movement.

Neither is the remedy for this situation difficult to find. While the absorption of surplus funds by the war and the practicing of economy by the public may check price advances, the labor situation, which is at the root of the whole trouble, can be solved only by action of the Federal Government. While Washington is raising an army and enlisting a host of farm laborers to feed it, the equal necessity for a far smaller supply of labor to build and produce the materials for building highways, vital to the transportation of this food, should not be overlooked. The Government must protect construction work.

What Water-Works Men Can Do

ACROSS the country the cry for economy has been echoing. It has carried with it a somewhat hysterical note, and just the sort of hard-headed advice that Howard E. Coffin, of the Advisory Committee to the Council of National Defence, gave a week or two ago was needed to tune down to their proper pitch the staccato shouts for ill-considered measures of saving. Nevertheless, the time has come to conserve intelligently all our resources—not by a wholesale shutting down of work, but by carrying on that work with greater dispatch and with less waste. We must keep the wheels of American industry moving.

To the water-works man many opportunities of service in these times of national emergency are open. Upon the shoulders of our citizens the financial burden for the war is to be placed squarely. With individual appropriations at Washington already running into many millions, this burden will not be a light one. As a measure of partial relief, it is necessary now, therefore, as never before, that our public works be well managed. The individual taxpayer will have enough extra payments to make without being compelled to assume those due to the inefficient operation of utilities.

First of all, water-works engineers in charge of other than gravity supplies must keep a close check on coal consumption at pumping plants. They must study both the mechanical and the human elements of their boiler-room problem—for a careless or ignorant fireman should be replaced just as quickly as a stoking device that is out of order. We will need all the coal we can save.

Closely related to the matter of pumping costs is the question of leakage—that elusive cause of waste which too often lies concealed under the blanket term of "water unaccounted for." Water-waste surveys should be made. Old pipe lines and leaking house fixtures should be made tight. Inspection and test of new conduits should be rigid. It costs just as much to deliver a portion of the daily flow through badly calked pipe joints into a nearby sewer as to send it into houses through service connections.

Now is the time for the water-works superintendent to preach against the profligate use of water. In cities where the per capita consumption has reached excessive figures the argument in favor of water meters becomes immediate. It is a highly significant fact that the City of Detroit, only two weeks ago, awarded what is claimed to be the largest single contract for meters ever entered into: 25,400 meters costing $209,880. From the superintendent in charge of the water-works of a Canadian city comes this timely bit of news: "Conservation of resources is the principal theme over here at present. We will pay close attention to waste of water, having an eye to checking up all flat ratings to insure the collection of proper amounts as our share of the good work."

It goes without saying that costs of water-works equipment and supplies will be influenced by our entry into the war. But is this the time to discontinue absolutely the purchase of needed material and machinery? Some superintendents, apparently, have adopted a policy of marking time. To them the following forecast of the market by an officer of a well-known pump-manufacturing concern should prove instructive: "We believe a great many superintendents and managers of water-works in the country do not appreciate the extreme importance of ordering equipment they may need in the next 18 months or two years, just as promptly as possible. All manufacturers at the present time are overloaded to a very large extent with industrial work, and the large volume of business being placed by the United States Government at the present time is having the effect of extending deliveries beyond anything experienced before." These words are worth weighing carefully; they must not be discounted as a mere plea for business. Many water-works officials have postponed buying because of present high prices of material and apparatus. There appears, however, to be no reasonable prospect of lower prices for some time to come. In fact, it may prove economical to purchase immediately, regardless of the level of present quotations.

These are some of the subjects that should be occupying the minds of water-works engineers today. Both the technical and the business sides of water-works operation demand the best thought of the officials in charge. An analysis of local conditions affecting plant and pipeline maintenance will disclose many opportunities for improved service and waste elimination. The times call upon each superintendent and engineer to put his house in order.

The Profession's Honor Involved

THE profession must not be tainted by fraud charges. Engineers will follow with keenest interest the outcome of O'Rourke's sensational suit against the Passaic Valley Sewerage Commission—not alone because a million dollars is involved, not alone because the vital subject of safe specifying and safe contracting is an issue, but before everything else because a member of the profession is openly charged with fraudulent statements.

For us the suit is O'Rourke *vs.* Brown; in the main, vital aspect the sewerage commission does not enter. The case is the losing contractor against the engineer, and the charge is deliberate misleading—fraud.

Judgment must be held in abeyance until the court determines the facts. In giving publicity to the case *Engineering News-Record* regrets the unfortunate fact that, while the charges are wholly unproved, it is compelled to spread the scandal of a grievous accusation. But charges against the honor of the profession may not for one moment be kept in concealment.

It is our hope that trial and defence of the accusation will be pressed to a clean-cut decision. The outcome then will be cause for deep satisfaction, whichever way it turns. We shall rejoice if the decision clears Mr. Brown—the honor of the engineering profession will be vindicated by the refutation of an ugly charge. But no less fortunate for the profession will it be if a clear finding of guilt should be returned, for in doing justice to a wronged contractor the court would issue warning most impressively that the high privilege and responsibility of the engineer must be guarded by a keen conscience.

Meantime a pointed lesson springs from the case: The supreme need of engineer as well as contractor for clear and fair specifying. Misunderstandings breed trouble—and it may be bad trouble, as the present case shows. This simple principle underlies every part and detail of contracts and specifications. It means just one thing: Specify clearly, and make the mutual agreements definite.

And clear means true, first of all. If conditions are accurately known, and accurately made known to the contractor, all must go well. If they are not known with certainty, then this fact must appear in the specifications; it must appear so definitely, with such positive and ample provision for variation of physical conditions discovered, that the mutuality of the enterprise—in plain words, fairness—will be assured throughout.

We are working consistently and steadily toward the practice of fair and exact specifying. Many are laboring with great and serious-purposed endeavor—witness the careful work done by the Miami Conservancy District in drawing its contracts and specifications—to attain this great end. All aid and support to such efforts!

New Features for Rapid Filters

FEW innovations seem possible in the design of filtration plants, but the Oshkosh plant, described on page 237, has several. An adaptation of the principle used in the Taylor air compressor to get air into an algæ-laden lake water, and a vortex-whirl apparatus to remove light material at the top and heavy at the bottom, are both novel features that designers should watch through the operating stage. If the aërator will do the work, and there seems to be no reason to think it will not, the simple apparatus using such a small amount of head will be applicable in iron-removal plants as well as for algæ-laden waters.

The ordinary way to obtain aëration is by means of a fountain or a drop of some kind requiring considerable head. Ten years ago at Point Deposit, James H. Fuertes, after a series of experiments, installed several concrete trays, one above the other, letting the water fall about ½ in. into 2 in. of water from orifices made out of brass awl ferrules. Pan aërators were experimented with at Urbana, Ill., to oxidize the iron, but in practice the water is simply allowed to drop into a reservoir several feet, and its entrance into the filter is through upward-turned pipes. In both cases the head consumed is much more than that used at Oshkosh.

The idea of using a meter of some kind to actuate a chemical proportioner is the method usually employed, although the particular details by which an adjustable positive amount is fed are new. The method of arranging the manifold so that the underdrain pipes may be flushed out in case sand enters them is similar in a way to the provision made for flushing out the sewage underdrains of the sewage-sprinkling filters at Washington, Penn.

With all these features Oshkosh will be one more Middle West stopping-point of interest for the sanitary engineer.

A Worth-While Field Test

THOUGH at first glance the consistency test for concrete proposed by Professor Thomas on page 244 of this issue may appear to be somewhat academic, yet there is good prospect of a highly practical application.

We know pretty definitely now that the amount of water in concrete affects its strength, and also that the precise amount of water for maximum strength is affected by the variation of material and conditions of manufacture. To tie up water content to quality then, requires continual field tests of strength, tests which are somewhat difficult to make and, what is worse, are not immediately available to control construction. If we make the fair assumption, however, that, while the amount of water to produce maximum strength is changed by various conditions, the consistency of the best concrete is apt to be nearly constant, we have opened up a new test, one that is easy and quick.

Professor Thomas' test is a step toward a rational determination of such consistencies, a determination based on something more reliable than the foreman's eye. The test is only in its preliminary stage and is suggestive rather than instructive. It is hoped that other experimenters will make further investigations of the same general nature.

The City Engineer Needs Help in City Planning

RESPONSIBILITY for city planning has rarely been definitely placed by American city charters. Practically never has it been placed upon the city engineer. Yet on him should rest the duty of building the more efficient city.

He meets some element or problem of city planning in almost every branch of his work. Many of them he solves by well conceived plans; but he rarely thinks of these elements or problems as a part of a unified city, designed to meet efficiently the manifold and sometimes conflicting needs of all its people.

The average city engineer is swamped with detail. He puts up with a dingy office in some back corner of the city hall. He has no real library. He travels little to observe what is being done in other cities. He has scant authority in the city government and is too prone to take a back seat and remain in it, silent, when he should stand on both feet and use his voice to lead his city council and the whole municipal public to the achievement of higher ideals. And sometimes his chief concern is serving a political party and holding a rather depressing, ill-paid job. These are some of the reasons why municipal engineers do less than they might, regardless of limitations beyond their control, as real city planners. The city engineer wants to rise above all these limitations and do his full part in making an efficient city. He wants help. How can it be given?

An experienced city planner, conversant as to theory and practice with the situation in at least two continents, urges elsewhere in this issue that municipal engineers in America be given their due place in city planning. Why has the City Planning Conference, which will hold its *ninth* annual meeting next week, got so little hold on municipal engineers? Why does the City Planning Conference again this year keep many interested engineers away from its meeting by holding it on the same date as the convention of the American Water-Works Association at Richmond, Va.?

Right answers to these questions, if their lessons were heeded, would increase the efficiency of municipal engineers in city planning. The city engineer is a figure of growing importance in this work.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcomed

Thinks Water Meters Would Not Be Profitable in Santa Clara

Sir—Many arguments in favor of water meters have been so well presented that there is a general impression that all services should be metered if the money is available. The following is an analysis of a particular case where meters would be inadvisable except to check abuses of the rules. Such abuses are irrigating at forbidden times and neglecting leaky fixtures.

Santa Clara is a town of 6000 inhabitants, in the center of the famous Santa Clara Valley, the home of the prune. The water-supply is obtained from artesian wells and is pumped into the mains under a pressure of 50 lb. per sq.in. For fire service the pumps are speeded up to give 100 pounds. It is considered necessary to maintain a pumping capacity of at least 1200 gal. per min. for fire service. The average consumption last June, the greatest of the year, was 725 gal. per min. A capacity of 1200 gal. per min., with a large storage tank, should be enough to care for the present consumption.

The first cost of a water meter in place is about $10. The yearly charges are: Repairs, 20c.; depreciation, 60c.; interest, 60c.; reading, etc., 20c.; total, $1.60.

Under present conditions the fuel oil and supplies to pump 1000 gal. into the mains cost 1.6c. With an up-to-date plant this charge would be much less. It is the only expense that a meter would reduce, so each meter installed would have to decrease the consumption 100,000 gal. a year, without lessening the revenue, in order to pay for itself. This is an average of 274 gal. a day, or about 2½ times the consumption per person in Santa Clara.

Among Santa Clara's greatest assets are her lawns, gardens and orchards. Many of these would be allowed to dry up if meters were set. For instance, the Menton place on the corner of Main and Santa Clara St. has been transformed from a show place to an eyesore by the setting of a meter. Every vegetable garden and orchard helps to reduce the cost of living for all. They should not be handicapped when the means of handicapping them costs money. Furthermore, these gardens help to make better citizens by keeping men and children at home in the long evenings. A municipality especially should consider all these things.

The time necessary to read meters is almost sufficient to test for leaky plumbing, with modern instruments. Where leaky plumbing is found or where rules are violated, setting meters may be the only remedy; but the setting of a meter in any other case in Santa Clara would be an unprofitable investment. Even in these cases the expense of a meter might be avoided often by a little diplomacy in the treatment of the offenders.

GEORGE L. SULLIVAN,
Professor of Mechanical-Electrical Engineering.
University of Santa Clara, Santa Clara, Calif.

[The arguments for selling water by meter include many factors that Professor Sullivan does not seem to have taken into account. Possibly some of them do not apply to Santa Clara conditions, but as a rule, they do everywhere else. In other places, meters prevent waste and thus postpone capital investment and increased capital and operating charges to keep pace with the increased demand for water and for pressure due to useless waste. In other places, plumbing inspection has failed as a means of keeping down waste, much of which has no relation to leaky plumbing and could be detected only by stationing an inspector on the premises of each consumer—whereas the meter is on the job every day, hour, minute and second. Many other places have fixed and all might so adjust meter rates as to guard against any real gain in skimping on the legitimate use of water for any purpose whatever, be it house, orchard or garden use. To assume the contrary is to transfer the burden of a water-supply from certain water consumers to others or else to place it on the taxpayers at large. The latter proposition is quite another thing. If the discussion be confined to selling water by flat rates as against measured service, then the whole matter may be summed up by saying that country-wide experience of water-works men has shown that the water meter is the only sure way of keeping down waste; and besides and beyond that, its use is justified and demanded as being the only possible way of distributing the burden of the public water-supply according to use and waste. However, we do not pretend to have said the last word on the subject. Our columns are open for short communications from those who have grappled first hand with water-waste and water-rate problems.—Editor.]

Low-Priced Rock Tunneling

Sir—The description, in *Engineering News-Record* of Apr. 12, 1917, of a one-man-per-heading tunnel is interesting as evidence of how cheaply tunnels of small cross-section may sometimes be driven. It appears that, even at the low price of $1.75 per lin.ft., each miner earned $3.50 per day of 9 hours.

In 1904-5 the writer had charge of sewerage work at Saugerties, N. Y., where it was necessary to drive a tunnel 410 ft. long in very hard rock—*cauda galli* formation. The tunnel was 4 x 6 ft., with no water to contend with, and was to contain a sewer which was afterward laid. The mucking was distributed at and a short distance from the tunnel entrance. The contract price for the tunnel was $7 per lin.ft. and the contractor sublet the labor at $6, furnishing the mucking equipment, explosives and hand drills. The equipment consisted of a second-hand car and track. The actual cost of 183 ft. of this tunnel was as follows:

1,500 lb. dynamite @ 10½c	$157 50
2,000 ft. fuse @ ½c	10 00
1,100 exploders @ 3c	33 00
800 fuse caps @ 1c	8 00
Labor	1,098 00
Total	$1,306 50
Cost per lineal foot	7 14

The use of the plant would be covered by not to exceed 10c. per ft. No appreciable difference in cost was noticeable in the driving of the remainder of the tunnel. The contractor made no money on this work, but the subcontractor, after paying his helpers, earned $454.55 for

the 1110 hours of his time on the 183 ft., or 40c. per hour. At the present time the cost of the tunnel would be nearly double the above. The subcontractor paid his men 20 and 15c. per hour and made about 2¼ ft. per day.

Tunnels of much greater length, but driven in shale, cost much less per foot or per cubic yard of material excavated.

CHARLES C. HOPKINS,
Rochester, N. Y. Consulting Engineer.

Corrections to Drain-Tile Report

Sir—In a summary of the conclusions contained in the abstract of Technologic Paper 95, "Durability of Cement Drain Tile and Concrete in Alkali Soils," published in *Engineering News-Record*, Apr. 12, 1917, p. 81, the sentence, "If these precautions are taken," should read "*Unless* these precautions are taken." Also in the section labeled "5," your article reads "sulphate of magnesium." We cannot state definitely that all the magnesium is combined with sulphate. Varying quantities of calcium, sodium carbonates and chlorides are also present and may be responsible for the disintegration found, although no definite statement can be made based upon the results obtained to date. This sentence should read, "sulphate *and* magnesium."

S. W. STRATTON,
Director Bureau of Standards.
Washington, D. C.

Will the Engineering Council Satisfy the Demand?

Sir—The Engineering Council, the plans for which were described in *Engineering News-Record* of Apr. 19, p. 161, is to be organized, "in order to provide for convenient *coöperation between the four founder* societies, for the proper consideration of questions of general interest to engineers and to the public and to provide the means for united action upon questions of common concern to engineers. . . . The trustees of the United Engineering Society may elect to membership in the Engineering Council other national engineering or technical societies, under such rules as the council prescribes, provided their nomination and said rules have the *unanimous approval of the governing bodies of the four founder societies.*" (Italics are the writer's).

In any discussion of the Engineering Council these fundamental principles of its organization should be given equal prominence to the features mentioned in your article, if for no other reason than that the understanding prevailed in the discussion on the floor of the Chicago Conference on Coöperation that the council was being planned as a federation of all engineering societies.

In analyzing the plans for the Engineering Council I wish to call attention to the structural features of two successful organizations for the purpose of comparison. During the past five years a federation of the commercial organizations of this country has been formed under the name of the Chamber of Commerce of the United States of America. It studies the work of existing progressive organizations and spreads this information to all commercial organizations desiring to increase their efficiency. It advocates standardization of association methods and urges the adoption of those found most effective. It acts on the assumption that the national Government desires to work in harmony with the commercial interests of the country and will accept their coöperation to make business legislation constructive.

It stimulates, fosters and develops the *local* commercial organizations from which it draws its power to be a force in the nation. When a referendum is taken on a national question, the legislators at Washington know that the result is the united opinion of many thousands of business men, and they give heed accordingly.

I wish to emphasize that the engineering profession will not come into its own until we have strong local autonomous organizations and until they are federated after the manner of the Chambers of Commerce. No one has yet discovered a form of voluntary organization that will be continuously effective until all the way through, down to the individual, there is in the minds of everyone a recognition of individual responsibility and a realization that each is the creator of results.

The plan of organization of the American Institute of Architects can also be examined with profit. When we consider that its total membership is not much over 1000, less than the number of members in any one of a half-dozen local engineering societies, we must conclude either that the architect as an individual is very much superior to the individual engineer or that the superiority is in combination, for no one is so bold as to say that any one organization of engineers has left as strong an imprint of its personality on the nation as has the American Institute of Architects.

The objects of the organization is "to organize and unite in fellowship the architects of the United States of America and to continue their efforts." This cardinal organization principle persists through all its parts. The institute is made up of chapters "which shall be incorporated under the laws of the state wherein they are located." The government of the institute is vested in delegates from the chapters, who meet in convention, and each chapter is entitled to two delegates plus one for every ten institute members. There are other places in the constitution where emphasis is placed on fellowship and democracy, and like the United States Chamber of Commerce, the institute is rooted in the soil.

The Engineering Council is to be composed of twenty-three members, five of whom are to be named by the governing boards of each of the founder societies and three by the United Engineering Society. It is hard to conceive how a more undemocratic method could be devised. Yet these 23 men, selected by the most indirect methods, twice removed from the body politic, are given authority to voice the opinion of 30,000 engineers [in the mind of the public of all engineers] "on public questions of common interest or concern to engineers." The organizers of the council seem to be unknowing and doubting the efficiency of democracy or afraid of it. It is a safe prediction to say that their voices will be of only academic interest to our legislators, whose ears are tuned to the sound of votes back home.

The quality of fellowship is entirely absent and doubtless was not intended to be found in the plans of the council. But without fellowship and acquaintance, from which come understanding and confidence, we cannot go far. The bureaucratic form of the council was doubtless created because of the belief that democracy is inefficient.

Whether efficient or inefficient, democracy is American and we must use it and work through it. But it is efficient, and any plan where action depends on harmonious unity of intelligent men cannot succeed unless the potential force of the individual is rendered dynamic. In other words, it is not possible to have an effective cooperation of engineers until we start with the local autonomous society as the roots of the tree.

It has been wisely said that, if a city is poorly governed, does not unite its citizens and is neglectful of their welfare, it is passed by the city that does these things. That the engineering profession has been passed by others is a fair statement; hence, there is need of improvement in its government. However, bad government, not good government, leads to reforms, so the future is full of hope.

C. E. Drayer.
Secretary, Committee on Engineering Coöperation,
Cleveland, Ohio. Cleveland Engineering Society.

Filtration, the First Line of Defense

Sir—The editorial which appeared in the *Engineering Record* of Mar. 10, page 370, under the caption "Filtration, the First Line of Defense," I read with much natural satisfaction, because of the broadness and incisive correctness of the convictions therein expressed.

In the Mar. 31 number of the same journal, pages 516, 517, there appeared two letters under the same caption as your editorial. The authors of these letters, William J. Orchard and John A. Kienle, are connected with concerns manufacturing chlorinating apparatus, and one, and it may be both, have had somewhat to do with attempts to safeguard the citizens of Milwaukee against water-borne disease through the chlorination of the water-supply of that city.

As I read over their letters I became more and more imbued with regretfulness that those so directly interested in water sterilization should show an unmistakable tendency to lose sight of the cardinal issue involved in the purification of polluted public water-supplies; and that they should display any antagonism toward filtration without which sterilizing processes, be they chlorination, ozonization, ultra-violet-ray treatment or what not, have so often been shown to fail.

Since the chlorinating treatment came into wide use some six or seven years ago, developing upon its successful application at the Chicago Stock Yards from 1908 on, and the publicity given to the success which attended the similar treatment of the water-supply of Jersey City, it has become an axiom among sanitarians that to be entirely reliable in its action at all times the sterilizing agent must not be hampered by the presence in the unsterilized water of pronounced physical imperfections, such, for example, as suspended matters which may envelop disease bacteria and thus afford them safe refuge against the action of the germicide.

Again and again has this point been proved. Indeed, in *Engineering News* of Feb. 22, 1917, page 332, it is stated editorially that Jersey City is about to apply for a reopening of the historic case of Jersey City vs. Jersey City Water-Supply Co., as a result of which the city was compelled to accept a chlorinating plant in lieu of other means which the city believes would prove more effectual in protecting the city's water-supply. Jersey City now claims that chlorination of its impounded but unfiltered supply does not afford adequate protection against water-borne disease, and is looking to the courts for relief.

While such facts as these are brought to the attention of the water-works public from time to time, through the medium of scientific papers, patently it has never entered into the mind of the sanitary expert to doubt the great advantage of chlorination when treating a properly filtered water. Mr. Kienle states his position fairly, I think, when he says:

"I do not want you to set this letter down as a bit of special pleading, for I have not the slightest desire to minimize in any way the importance of filtration as 'permanent construction.' I would consider myself most unworthy if I should neglect any opportunity to recommend filtration whenever a community can afford it—and few cannot when its value is realized."

Notwithstanding this frank and perfectly logical and correct statement there seems to be a strong tendency on the part of the promotors and advocates of chlorination to *allow* filtration a place in the necessary scheme of entire reliability in the purification of any polluted water-supply, rather than to unhesitatingly *accept* its unquestioned *necessity*. Mr. Orchard says:

"I agree wholeheartedly with you that the filtration of any *heavily polluted* water-supply is *desirable*." All of this appears to me as "damning with faint praise."

The italics in the quotation above are mine as showing that, according to Mr. Orchard, unless a water be heavily polluted it need not be filtered and can effectually be sterilized. But the record shows that moderately, or even slightly, polluted and unfiltered waters may contain matters in suspension which will serve as protective sheaths for disease-producing germs, and so destroy the sure reliability of chlorination.

Believing heartily in Mr. Kienle's assertion quoted above, and freely accepting the special plea which he makes, this letter will perhaps make clear the entire necessity for the removal from water of color, turbidity and suspended matters generally, and *removal* of bacteria in large percentage amount as an antecedent to any method of sterilization, including chlorination, applicable on a practicable basis for the satisfactory purification of public water-supplies; and I feel sure that this position will receive the support of all chlorinating experts.

Robert E. Milligan,
President, New York Continental Jewell Filtration Co.
New York City.

Mine Caves and Building Repairs

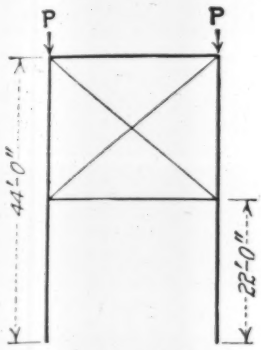
Repairing and protecting Scranton schools on account of damage by subsidence over coal mines have cost well over $100,000 in six years, according to a tabulation by the school district, published in the Scranton *Times* of Mar. 22. In 1910 a $40,000 school was practically wrecked, and rebuilding cost $46,000. Further subsidence under the same school in 1916 led to more expense, but the building is now closed as unsafe. Six other schools have cost for similar repairs $5700, $90, $2700, $3400, $1800 and $300. Purchasing pillars of coal under another school, as protection, cost $1000. Concrete pillars were built under still another, at a cost of $1100.

THE ENGINEER IN FIELD AND OFFICE

A Department Devoted to Details of the Day's Work

How Apply Column Formula Here?

HOW to apply a column formula to the posts shown in the accompanying sketch is the question raised by Charles A. Kyle, Bridge Engineer of the Montana State Highway Commission. The posts are each two 6-in. 10½-lb. channels laced, with webs of channels in the plane of the bracing. When, say, the American Bridge Co. formula is used, $p = 19{,}000 - 100\frac{l}{r}$, is the unsupported length 44 ft. or 22 ft.? Lacking further details, it must be assumed that the fixity of the lower ends of the posts is doubtful. Then the posts can bend as if free at one end; hence, $l = 12 \times 44$, unless other bracing (as upper and lower laterals in a bridge, well held by strong end portals) holds the ends of the post in their original relative position. It is a fine question whether, in sway bracing, the laterals may be assumed to hold the posts so truly in line.



WHAT IS THE COLUMN LENGTH?

Wedge-Shaped Survey Stake Stays in Place Longer Than Straight Stake

By N. S. MULLICAN

City Manager, Thomasville, N. C.

CONTRACTORS are sometimes put to a great deal of inconvenience and are forced to lose time and make mistakes by the engineer's stakes being lost or displaced. The ordinary stake as used by the engineer is so made as to be very easily knocked out of position. This defect is due to the way in which the stake is sharpened.

The left-hand sketch gives the form of stake ordinarily used—a straight stick sharpened with a short slope from both sides. When such a stake is driven, the point is the only part firmly seated, while the body of the stake is as large just above the point as the rest of the way up, so that the stake just stands in a hole made by the point. This shape accounts for the ease with which most stakes are displaced. However, if the stake be made of the form shown at the right, it will be found to give much greater satisfaction. This stake is sharpened only on one side, but the slope extends three-fourths the length of the stake. When driven into the earth, the stake is held very much more firmly than is the other kind, because the taper is much longer and therefore the earth adheres to a greater length of the stake. It is very difficult to draw this type of stake out of the earth when once driven in. If exposed to traffic, as in the case of streets and highways, the stakes are sometimes broken off at the ground, the stake breaking before it pulls up. In this case the point is still in position and can be found and replaced.

WRONG AND RIGHT WAY

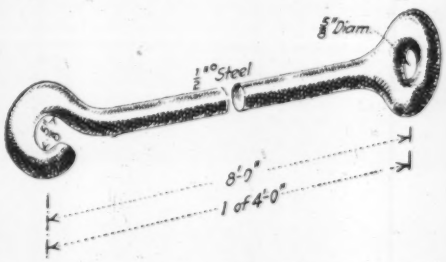
The writer at one time made a test of these two types of stakes on a highway on which the traffic was very heavy. The following was the result: Equal numbers of the two kinds of stakes being used, under equal exposure, 14% of the first type were entirely lost, while only 2½% of the other were lost.

Hook Connections Extend Auger Used in Making Borings for Subsidence

By M. M. WILCOX

Pilot Engineer, Chicago, St. Paul, Minneapolis & Omaha Railway

HOOK CONNECTIONS instead of screw couplings were used to advantage to extend the augers with which borings were made to test the subsidence of embankments in connection with the Government valuation of the Chicago, St. Paul, Minneapolis & Omaha Ry. As some of the holes were more than 50 ft. deep, to unscrew joints every time the auger was pulled up for cleaning would have been slow work. With the hook connections the rods were disconnected as fast as they were lifted from the hole, and still there was no chance for them to become disconnected while in a vertical position.



EXTENSION BAR FOR BORING AUGER

The tools used for the tests were a carpenter's 2-in. auger, a 2-in. pod auger, a short drill, two bars, 5 and 8 ft. long respectively, both of 1-in. drill steel, a supply of 2-in. single-strength pipe and couplings for casing the hole in soil that caved, a Channon pipe lifter with a Little Giant pipe holder, wooden mauls for driving the casing, a shovel and post-hole digger for use in going through the ballast, a short piece of heavy log chain with hook and eye, two pipe wrenches and a supply of extension rods. The augers and drill each had a shank 4 ft. long with an eye at the upper end so that an extension rod could be hooked on as the hole was lowered. These extension rods were of ½-in. round steel, 8 ft. long, with an eye at one end and a hook at the other. There was one rod 4 ft. long to use in connection with the longer ones, so that there was never more than 4 ft. out of the ground at a time.

The method followed in making these tests was to put a hole through the ballast with the shovel and post-hole digger, then set in a length of the 2-in. casing and use the auger the rest of the way, lowering the casing as the hole progressed. If the fill was of clay or any material

that would stand without caving, it was often possible to complete the hole with only the one piece of pipe, as that would keep the ballast out of the hole. Where the fill was dry sand, or if there was water on the sides of the fill, it was necessary to keep the casing close to the bottom of the hole; and in some holes better progress was made with the casing driven lower than the hole, the material being bored out inside of the casing.

In a number of holes small gravel stones were found which caused a great deal of trouble, until the writer had a 3-ft. piece of 1½-in. pipe (the largest that would go inside the 2-in. casing) fitted with an eye at one end so that the extension rods could be hooked in. This pipe was churned up and down in the hole until the gravel had become wedged in the pipe. In this way any stone that would go in that pipe could be removed. At times the stones were too large to be removed in that way, and it was necessary to drive the casing down until the stone was wedged in it. The casing was then pulled and cleaned. In some holes it was possible to replace the casing without losing any of the hole, but at other times it was found that from 5 to 50% of the hole had filled and would have to be bored out again.

District Maps Make Water-Main Shutoff Locations Known to Every Foreman

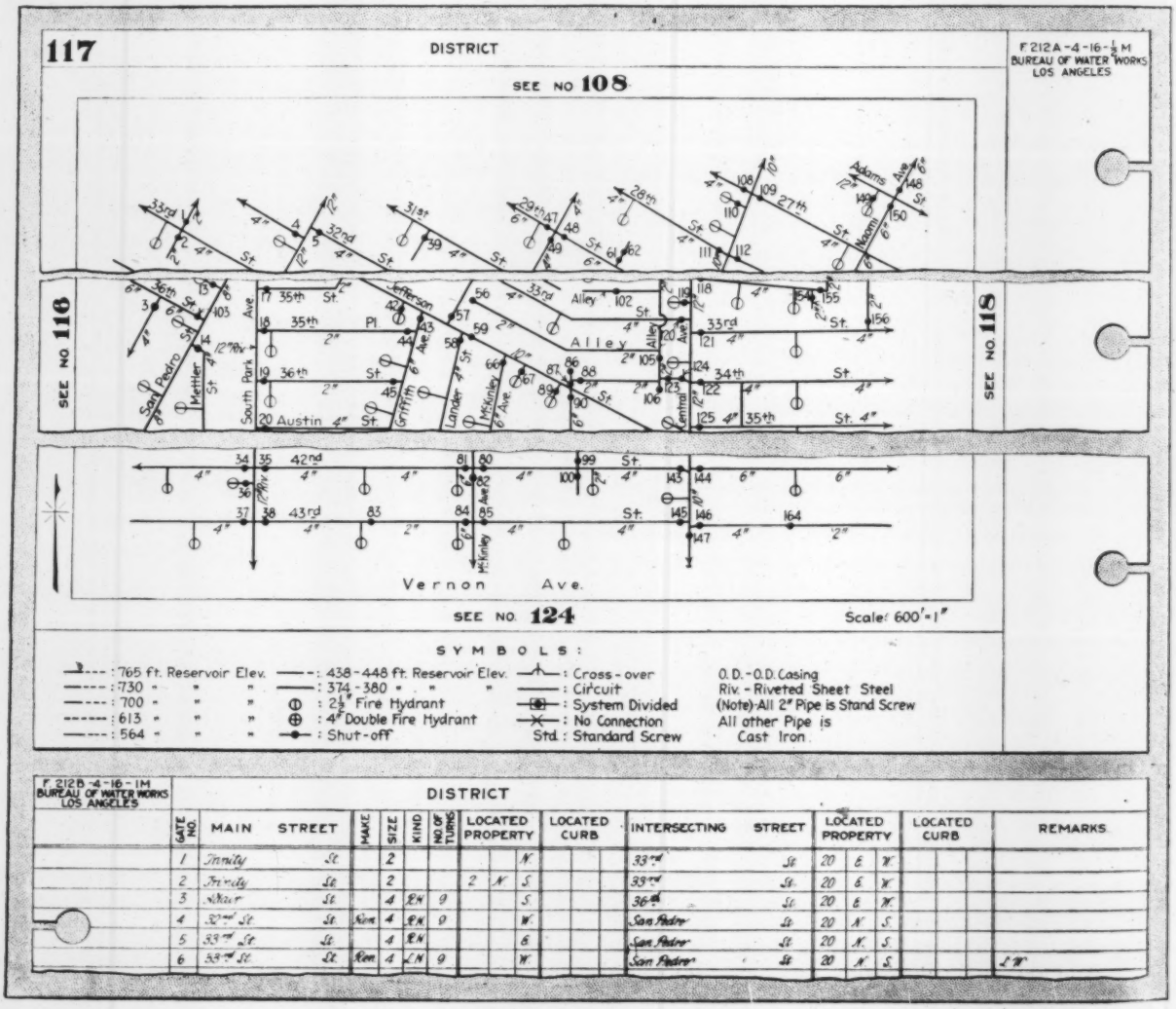
By B. K. RICHARDSON

Chief Pipe and Gate Recorder, Los Angeles Water-Works Bureau

RECORDS that enable employees quickly to shut off any part of the water-distribution system have recently been installed in the Bureau of Water-Works of Los Angeles. Maps of the entire distribution system are kept in square-mile sections on 11 x 11-in. tracings on a general scale of 600 ft. per in. For congested areas quarter-mile sections and a scale of 300 ft. per in. are used. These maps show mains, fire hydrants, shutoff gates, air valves, blowoff valves and large-size domestic-service gates. Elevations of reservoirs supplying various districts are shown by broken lines.

All gates on a map section are listed in tabular form on tracings of the same size as the maps and having the same section number as the corresponding map. Each shutoff has the same number on the map and in the table.

Blue-line prints of the maps and tables in loose-leaf book form are carried by each foreman in the field, for



F 212B-4-16-1M BUREAU OF WATER WORKS LOS ANGELES — DISTRICT

GATE NO.	MAIN STREET	MAKE	SIZE	KIND	NO OF TURNS	LOCATED PROPERTY			LOCATED CURB			INTERSECTING STREET	LOCATED PROPERTY			LOCATED CURB			REMARKS
1	Trinity St.		2					W				33rd St.	20	E	W				
2	Trinity St.		2			2	N	S				33rd St.	20	E	W				
3	Alkar St.		4	R.W.	9			S				36th St.	20	E	W				
4	32nd St. St.	Kem	4	G.W.	9			W				San Pedro St.	20	N	S				
5	33rd St. St.		4	R.W.				E				San Pedro St.	20	N	S				
6	33rd St. St.	Kem	4	C.W.	9			W				San Pedro St.	20	N	S				L.W.

LOS ANGELES WATER-WORKS HAS DISTRIBUTION-SYSTEM GATE RECORDS FOR EACH FOREMAN
Originals are 11 x 11-in. blue-line prints assembled in loose-leaf book form

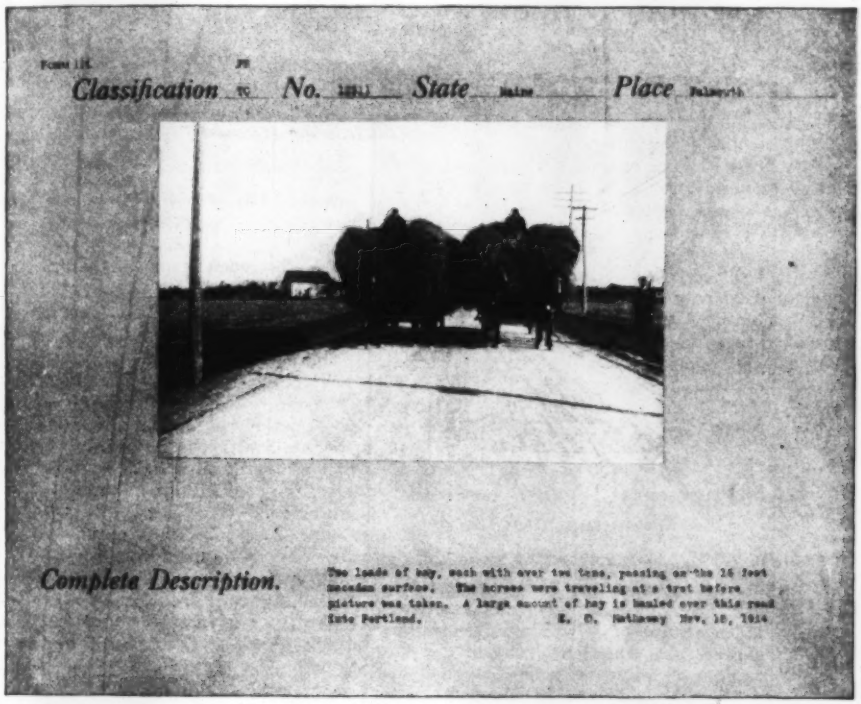
the district in which he works. These books are indexed by street names. Both the original records and the books of prints are kept up to date by noting additions and changes as made.

Rolling of Railway Roadbed Gives Even and Compact Subgrade

THE USE of a steam roller for consolidating railway roadbed is comparatively new. The method was discussed in the report of the Roadway Committee at the recent convention of the American Railway Engineering Association. The rolling is stated to have proved effective in providing a hard and dense surface for the ballast and in preventing the formation of soft spots and water pockets. To some extent, also, it reduces the trouble from settlement of fills; but as the rolling is done only on spaces between them. The ballast and clay were thoroughly mixed, and the clay had worked up into the ballast to within 6 in. of the ties. The clay was puddled so that it held pools of water at this level, which was several inches higher than the shoulder of the embankment outside the ballast.

Rolling seems to have prevented the material from mixing with the ballast, in spite of the fact that the depression of that part beneath the ties has formed a trough with no outlet for drainage except by percolation through the roadbed. The track on the rolled roadbed is more easy riding, it is stated, is notably better in line and surface and is maintained with less labor than the adjacent section of track on roadbed finished in the ordinary manner.

The Erie R.R. is making two tests of this kind on the roadbed for its new second track near Lomax, Ind. One


Classification
No.
State
Place
Complete Description.
Two loads of hay, each with over two tons, passing on the 16 foot macadam surface. The horses were traveling at a trot before picture was taken. A large amount of hay is hauled over this road into Portland.
E. C. Mathewey Nov. 10, 1914

Filing Photographs

TO FILE 15,000 photographs in a way in which they can conveniently be utilized, the United States office of Public Roads and Rural Engineering uses 8½ x 10½-in. envelopes of the type shown, with a print of the picture pasted in the center of the envelope. Extra prints may be kept in the envelope. There are about 18 subject classifications. As the picture shown happens to have two classifications, "P. R." meaning "Post Roads" and "T. C." "Traffic," an envelope is filed under each subject. The number is that of the negative. The negatives are filed separately seriatim. The photographs are filed by subjects in the first instance, by states in the second and by places in the third.

the completed fill, the effect on the ultimate settlement of high fills may not be great.

In 1910-11 the Bessemer & Lake Erie R.R. adopted this treatment on 2½ miles of roadbed for new second track. The fill was of clay, about 8 ft. high, and the subgrade was thoroughly compacted with a 10-ton steam roller. Inspection in 1916 showed a hard, level surface that shed water poured upon it and that had not mixed with the ballast. The part directly under the ties had been depressed uniformly 5 or 6 in. below the original level, while laterally it had been depressed about 1 in. more under each tie than in the spaces between the ties.

Inspection was also made of a fill of the same material, made at the same time and in the same manner as the other, except that the surface was not rolled, but simply leveled with a spreader. The part under the ties was depressed irregularly from 5 to 9 in., and under the ties the depression was from 1¼ to 1⅞ in. more than in the section will be on a clay fill 18 to 20 ft. high and the other on a fill of light sandy loam, 5 to 8 ft. high. In each case half the length of the fill will be rolled, and then sprinkled with oil to prevent the material from becoming mixed with the ballast.

Prefers Home-Made Copying Paper if Necessary

Home-made copying paper, prepared by rubbing common scratch paper with a soft lead pencil, is more satisfactory than carbon paper for transferring topography from field sheets to the office map, writes F. T. Howes, resident engineer of the Northern Pacific Ry. at Manhattan, Mont. Lines traced on a map made from such copying paper can be easily erased, he states, while the erasure of carbon-paper lines is not so readily accomplished.

NEWS OF THE WEEK

Current Events in the Civil Engineering and Contracting Fields

New York Contractor Begins Wooden Ship Construction

The Foundation Co. Rushes Work on Ten Vessels, Requiring 17½ Million Feet of Lumber

As a result, it is said, of volunteering its services to the Government, The Foundation Co., of New York City, has been ordered by the Shipping Board, of which General Goethals is chief, to construct ways and begin immediate work on the building of the first ten of the fleet of wooden cargo carriers with which the Government expects to break Germany's submarine blockade. Within thirty-six hours the company had leased a site near New York harbor with 1800 ft. of river front and space for fourteen ship ways, and had started surveys for the necessary dredging. On the following day, May 1, it was expected that pile drivers would be at work on the construction of the ways.

Meanwhile, plans for the standardized wood vessels were being revised to meet the suggestions of lumber mill representatives for speedier and more efficient construction, and it was expected that orders for 17½ million feet of lumber for the first ten vessels would be in the hands of the producers early this week.

The milling of the standard timbers is said to be the controlling factor in the time of completion for the first batch of vessels, prompt rail delivery having been already arranged. Pending the placing of these orders and the receipt of estimates on deliveries from the mills, no time schedule for the construction of the vessels can be given out. It is thought, however, that the ship ways, of pile and stringer construction, will be ready in advance of the receipt of lumber for the hulls. Operations are being carried on under the direction of C. A. D. Bayley, vice president of The Foundation Co.

Detroit Engineers Favor Conscription

The annual banquet of the Detroit Engineering Society on Apr. 21 was attended by 600 members. A motion indorsing compulsory military training and service was passed. Maj. J. H. Poole, a member of the society, who is recruiting a regiment in Detroit, discussed military service and training. C. E. Drayer spoke on "Engineering Coöperation." M. H. Leland, president of the Cadillac Motor Car Co., addressed the society, as did William P. Putnam, the new president, who presented a proposition to acquire a permanent clubhouse and auditorium at a cost of $75,000.

Have You Bought Your Bond?

The poster on the opposite page tells its own story. It is the work of the illustrating department of the McGraw-Hill Publishing Co., Incorporated.

Engineers Asked To Coöperate in Military Census

Coöperation in the taking of the military census of New York State, ordered by the governor to be taken in the near future, is asked of the membership of the American Society of Civil Engineers in a circular sent out by Charles Warren Hunt, secretary. Every resident will be required to report at one of the designated enrollment depots. In each county the census will be under the supervision of a volunteer county committee. Chairmen have already been chosen for most of these committees, and their names and addresses are listed. At least five helpers or recording clerks will be needed at each of the 6000 enrollment depots. Each member of the society is asked to coöperate actively in this work and to forward to the chairman of his committee the names and addresses of men and women who will serve as recording clerks.

The census will probably be taken from May 10 to May 15.

Engineers' License Laws of Wyoming Simplified

As mentioned on page 352 of the Mar. 3 issue of the "Engineering Record," the licensing laws for engineers in the State of Wyoming proved very successful. The bill provided for five classes of engineers, each subject to a different examination. However, during the 1917 session of the legislature, this law was simplified, the number of classifications being reduced to three. The old law specifically defined what engineers of each class could and could not do professionally, but the recent legislation is contrastingly simple. The first class of examinations, for which a surveyor's license is issued, permits land surveying, laying-out and applying for irrigation work for the reclamation of not more than 1000 acres, and the design of reservoirs where the depth of water to be stored will not be more than 10 ft. The second class, known as junior engineers, is licensed to do any sort of engineering; while passing the third or senior engineers' examination indicates, further, a knowledge of irrigation law. Engineers now holding licenses will have them continued without examination, but with a certain logical reclassification, upon the payment of a small fee.

Contractors Come Forward!

Those Who Would Help Country by Doing War Construction Work Register Now

In view of the fact that the Federal Government is already making good use of contractors, members of the General Contractors' Association of New York and others who have volunteered the services of their plants and organizations, and of the fact that much more work will undoubtedly be required which can be handled most efficiently by the contractors' organizations already in existence, this journal invites immediate replies from every contractor in the country to the following questions:

What class of work is your organization experienced in and able to undertake at once? (List each class separately.)

What size of job (in dollars) have you the plant and organization free to undertake immediately? (Separate reply for each class of work listed above.)

In what territory are you familiar with conditions, and able to operate to advantage?

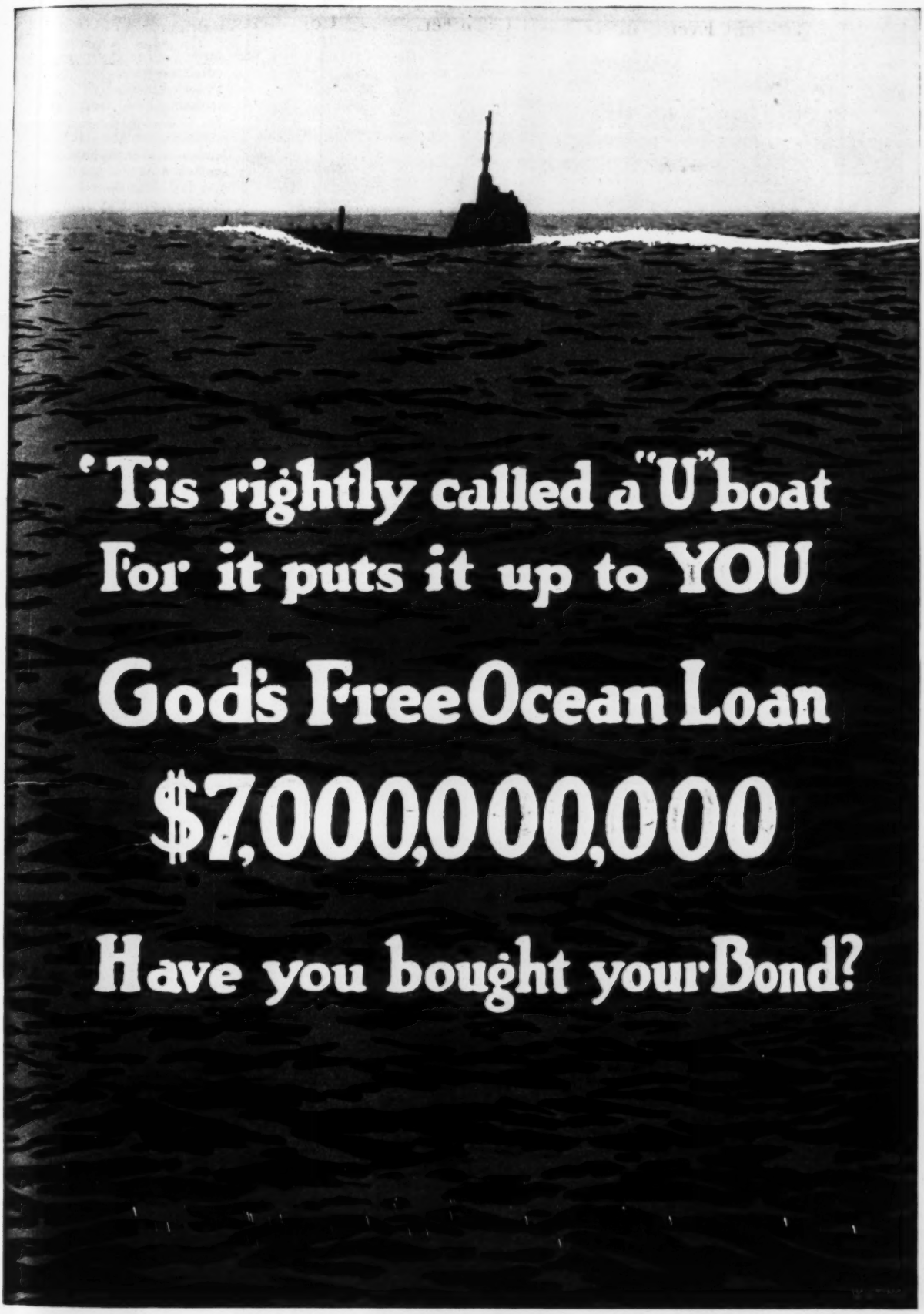
What work are you doing (such as road, railroad, other transportation construction, industrial plant construction, etc.) which is essential to the conduct of war, and should be finished before the organization on it is disrupted?

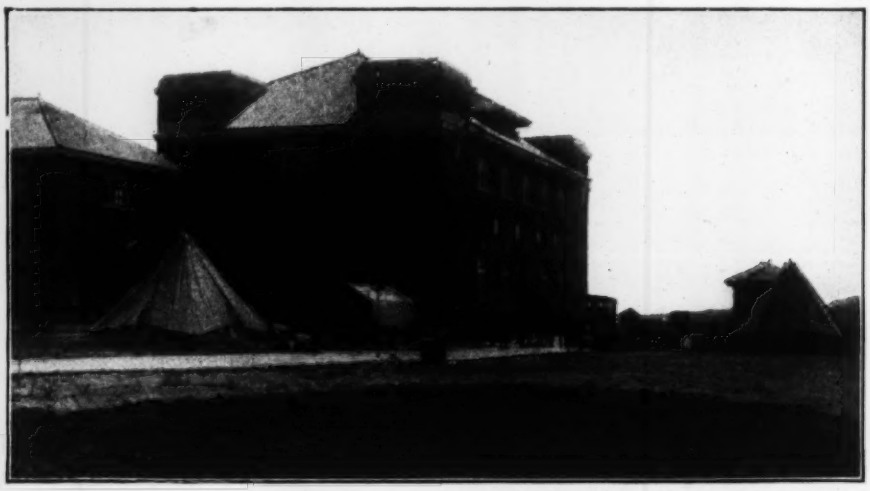
State size and qualifications of military engineer unit your organization could furnish for field service here or behind fighting front, such as railway, highway, and camp construction and maintenance. (For large organizations.)

As pointed out on page 270 of this issue, the organizations of many of the contractors in the country would be exceedingly valuable to the Government organizations, and many contractors away from the Atlantic seaboard are already anxiously inquiring how they can best place themselves at the service of the country. Supplementary to the industrial census of the country, and to inform the Government of the location and capabilities of contractors able to carry out work of all sorts, as well as to put contractors having the necessary qualifications in touch with the Government Departments which they are best fitted to serve, is the purpose of this census.

A few of the classes of work which can be carried out to advantage by contracting firms, and which may be among the first things wanted follow:

Construction of Federal buildings warehouses, etc.; enlargement and construction of shipbuilding plants; water


'Tis rightly called a "U" boat
For it puts it up to YOU
God's Free Ocean Loan
$7,000,000,000
Have you bought your Bond?



Baltimore Water-Wo[rks] Guarded by Militi[a]

Baltimore is taking [no] chances with its [new] mechanical filters. S[ince] the break with Germa[ny], members of the Maryland National Guard have been stationed at the plant night and day. The accompanying view, supplied by James W. Armstrong, engineer in charge of the filtration division, shows the soldiers' tents pitched near the main buildings of the plant. The works cost about $1,500,000 and are designed for a capacity of 128,000,000 gal. daily.

terminal and harbor construction; dredging; construction and enlargement of private plants for manufacturing munitions and supplies; construction of highways and railroads; construction of other facilities for moving, handling and storing food products; and direct military service as engineer troops in the field.

It is thought that if the contractors of the country can be induced to cooperate, better arrangements may be made for continuing without interruption work which is in no sense of a military nature, but the completion of which would strengthen the country as a whole for carrying on the war. For example, continued highway construction in the interior farming states cannot be considered in any sense a military measure, yet it would be of great economic benefit in cheapening and hastening the transportation of crops to local markets and railway lines.

All replies to the above questions should be directed to the editor, "Engineering News-Record," 10th Ave. and 36th St., New York City.

Essex Border District To Build Water and Sewerage Works

By an act of the last session of the Provincial Parliament of Ontario, Canada, there was created the Essex Border Utilities Commission for the purpose of studying the construction of joint works for the supply of water, collection and disposal of sewage of Ford, Windsor, Walkerville, Sandwich, Sandwich West and Ojibway, the latter being the proposed new town of the Canadian Steel Corporation, Ltd.

The mayor of each city or reeve of each township, together with one elected member, constitutes the Board of Commissioners. The engineers of the several communities are Owen McKay, representing Ford and Walkerville; M. E. Brian, city engineer of Windsor; C. R. McColl, representing Sandwich; J. J. Neuman, representing Sandwich West; and Morris Knowles, representing Ojibway. These constitute a Board of Engineers acting in an advisory capacity with Mr. Brian as chairman. Morris Knowles, of Pittsburgh, Penn., and Windsor, Ont., is Consulting Engineer of the Essex Border Utilities Commission and is preparing a report upon a metropolitan or joint system of water-supply and sewerage. It is expected that this report will be submitted within a few weeks.

Industrial Engineers To Organize for Preparedness

An ambitious movement for the cooperation of engineering and business interests to meet the present industrial and military conditions is to organize the American Society of Industrial Engineers. This is planned in connection with the National Conference on Industrial Preparedness, which is to be held at Chicago on May 22 to 26, under the auspices of the Western Efficiency Society.

The various leading engineering societies and business or commercia organizations as well as individual efficiency engineers and all those interested in improving the output of manufacturing plants, have been invited to combine and assist in the formation of the new society. One of its main objects is so to combine all industrial and manufacturing interests that the Government's Council of National Defense will have only one comprehensive organization to deal with in its arrangements to utilize the resources of the country for the war in which the United States is now taking its part.

War Postpones Railway Meeting

The annual meeting of the American Railway Association, which was scheduled for May 16 in Chicago, has been indefinitely postponed. It is felt by the Executive Committee that patriotic reasons looking to the conservation of time should be ample warrant for this decision.

Two Million Dollars for Navy-Yard Rush Buildings

Two large reinforced-concrete buildings, containing an aggregate floor space of more than 1,000,000 sq.ft., have been contracted for by the Federal Government for the Brooklyn navy yard. These buildings, to cost nearly $2,000,000, are to be started immediately and are to be carried through at all possible haste, so as to make them available next fall. One building, 11 stories high and 360 x 180 ft. in plan, is to be for supply storage; the other, 10 stories high and 200 x 200 ft. in plan, is for provisions and clothing. A novel feature of the work is that, owing to the imperative demand for the buildings, the contract was let without bidding, but with most forceful instructions as to early completion. The contract was awarded to the Turner Construction Co., of New York City.

To Use Consulting Engineers in Camp-Site Selection

The engagement of consulting sanitary engineers in connection with the selection of sites for various large military camps is under consideration by Brig. Gen. W. M. Black, Chief of Engineers, U. S. A. Letters have been sent out asking whether various organizations will be available for consulting services, not only in the selection of sites, but for the design and superintendence of sanitary works.

The basis of compensation under which several engineers in Chicago propose to serve their country is bare cost of organization plus major's pay for the principal.

Many camps of frame shelters for divisions of the Regular Army and National Guard, consisting of 28,000 men and 9000 animals each, will be established. Water-supply and sewage disposal must be given consideration as most important factors in the selection of sites; and when a site is once selected, construction must proceed rapidly before the troops arrive.

Largest Meter Contract Awarded

What is claimed by Theodore A. Leisen, general superintendent, Board of Water Commissioners, to be the largest meter contract ever given out has just been awarded at Detroit. At a meeting of the board held Apr. 24, a contract for 25,400 meters was awarded to the Gamon Meter Co., at a total price of $209,880.

Pearson Succeeds Elliott on the New Haven

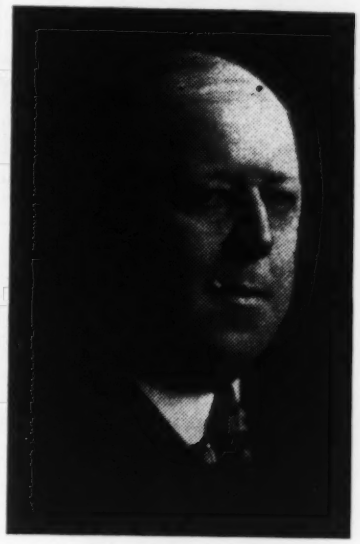
After Four Years Mr. Elliott Turns Upbuilding of Road Over to His Assistant

Howard Elliott has resigned as president of the New York, New Haven & Hartford R.R. and has been succeeded by Edward J. Pearson, vice president of the company. Personal reasons are given for the change. It was in August, 1913, that Mr. Elliott was called to restore the credit and standing of the New Haven properties after years of mismanagement, and the task was considered as difficult as confronted any railroad president. Mr. Elliott states that he considered retiring to less severe work a year ago, but thought the work of reorganizing the staff had not gone far enough. Now he feels justified in withdrawing from active management, although he will remain a director and adviser.

Mr. Pearson, his successor, has been with the company as vice president for a year only, having come from the Texas & Pacific Ry. in March, 1916. Like Mr. Elliott, he is a civil engineer by training. He was graduated from Cornell University in 1883, after which he entered the service of the Northern Pacific Ry. as assistant engineer on construction. Two years later he was appointed supervisor of bridges, buildings and water-supply. In 1892 he was made principal assistant engineer and in 1904 became chief engineer. He remained in this position until 1911, when he was called to the Missouri Pacific system as first vice president. He went to the Texas & Pacific in a similar capacity in 1915, but remained there only a year, as noted.

Mr. Elliott was graduated from Harvard University in 1881. His first work was engineering, with the Chicago, Burlington & Quincy R.R.; but while he remained with this road until 1903, he soon left the engineering department. He resigned from the Burlington as second vice president to accept the presidency of the Northern Pacific, and remained president of this road until called to the New Haven in 1913.

HOWARD ELLIOTT



EDWARD J. PEARSON

New York West Side Improvement May Go Forward

Opponents of the proposed West Side freight improvement of the New York Central R.R. in New York City received a body blow Apr. 18. Justice Manning, of the Supreme Court, dismissed the action brought by the Society for the Prevention of Municipal Waste to restrain the members of the Board of Estimate of the city from executing the proposed contract with the railroad. In his decision he stated that there was neither merit in the plaintiff's suit nor justification for its action in law or in morals. He asserted also that he would vacate any injunction that may have been granted.

Water-Waste Survey To Be Made at Buffalo

To make a water-waste survey at Buffalo, N. Y., $10,000 has been put at the disposal of City Commissioner Arthur W. Kreinheder and Water Commissioner George C. Andrews. Mr. Kreinheder holds out hope that the heavy waste for which Buffalo is notable may be reduced so that one of the two pumping stations may be shut down.

Contractors To Build Food Carrying Ships on Pacific Coast

Arrangements have been made by the Federal Shipping Board, it is announced, with a second engineering and contracting firm in New York City to build wood cargo vessels. This firm, Sanderson & Porter, will build its ships in two yards on the north Pacific coast, sites for which are being sought. Each yard will contain ten ship ways. It is also understood that ship yards at Jacksonville, Fla., and Beaumont, Tex., have received contracts for more of these vessels.

Springfield (Mass.) To Have Industrial Exposition

A large exhibition of American-made products is to be held in the Exposition Buildings of Springfield, Mass., June 22 to 30. The main object is to show United States manufacturers and merchants how to extend their trade at home and abroad. A number of addresses designed to point the way will be delivered by export authorities. All communications should be addressed to John B. Simpson, general manager, Eastern States Exposition, Springfield.

Three Large Piers for Staten Island, New York

Ground was broken recently for three large piers to be built between Clifton and Stapleton, on the northeast shore of Staten Island, New York, just north of the Narrows. The piers will be more than 1000 ft. long and will be served on the land side by the Baltimore & Ohio R.R. The entire development, including piers, warehouse and railroad yards, will, it is said, occupy more than 30 acres.

The development is backed, among others, by A. B. Pouch, president of the American Dock Co., who is to organize the Pouch Terminal Co., with a capitalization of $2,000,000.

Highway Official's Plan Aids Preparedness

New Jersey is the only state that has so far made any study of the military aspect of its roads, according to information just obtained from Washington. The census in New Jersey was completed some time ago and covers not only the condition of the highways, but the location and accessibility of quarries containing suitable stone, the location of road rollers and scrapers, and other detailed information germane to road construction and repair. This information was gathered and tabulated solely that it might be quickly available in case of war. State Road Commissioner Edwin A. Stevens has been requested by Adj. Gen. Charles W. Barber to prepare blanks, which will be sent to all state highway departments so that the War Department may possess similar information covering the whole country.

Engineer Reserve Officers Will Be Ordered Into Service

Warning Issued by Chief of Engineers To Prepare for Call to Training Camp Duty

The Chief of Engineers has warned the officers of the Engineer Reserve Corps that they may expect immediate orders to report to the various officers' training camps being organized, as noted in "Engineering News-Record," Apr. 26. This includes Class A majors and below that rank class A and B men, and exempts only men engaged on government work in connection with military service or supplies; private affairs will not be allowed to interfere with attendance at camps. Some of these reserve officers may be returned to civil life after August or may be held for further training. No information is available as to probable movements of these officers after August.

Pay During Training

It is expected that citizens recommended for attendance at the officers' camps will be paid at the rate of $100 per month, until reserve-corps commissions are issued to them. Officers will get the pay of their grade.

By an amendment to the Army Draft Bill passed by the House and Senate, Apr. 28, the President is authorized to raise, by draft or voluntary enlistment, such special and technical troops as he deems advisable, and to provide officers from the regular army and reserve corps. This covers the engineer enlisted reserve units which the chief of engineers has been building up, and will make it possible to place the enlisted reserve men in active service in the New York, Pittsburgh, Cleveland and other regiments as fast as they are enrolled. To date the number of enrollments has been satisfactory.

Personal Notes

George T. Hand, of South Orange, N. J., for the last five years division engineer of the Delaware, Lackawanna & Western R.R., has resigned to become chief engineer of the Lehigh Valley R.R. Mr. Hand entered the service of the Lackawanna 16 years ago. Previous to that time he was employed by the National Docks R.R.

Gaylord C. Cummin, for the past two years city manager of Jackson, Mich., has been appointed city manager of Grand Rapids, Mich., by the new city commission. He will receive an annual salary of $10,000.

John H. Gregory announces that the firm of Hering & Gregory, consulting engineers, 170 Broadway, New York City, was dissolved on Apr. 30. Mr. Gregory will continue his practice as a consulting hydraulic engineer and sanitary expert at the above address and will give special attention to the subjects of water-supply, water purification, sewerage, sewage disposal, and garbage and refuse disposal.

R. J. S. Pigott, formerly construction engineer in the motive-power department of the Interborough Rapid Transit Co., and for the past two years power superintendent of the Remington Arms-U.M.C. Co., of Bridgeport, Conn., has resigned to become associated with the Sanford Riley Stoker Co., Worcester, Mass. He is retained by the Remington company in a consulting capacity on power and service.

C. R. Richards, professor of mechanical engineering and head of that department at the University of Illinois since 1911, has been appointed dean of the College of Engineering and director of the Engineering Experiment Station of the university, to succeed Dr. W. F. M. Goss, who has resigned to become president of the Railway Car Manufacturers' Association of New York. Professor Richards graduated from Purdue University in 1890 and has been, successively, instructor in mechanical engineering at the Colorado Agricultural College and professor of practical mechanics, professor of mechanical engineering and dean of the College of Engineering at the University of Nebraska. He served for two years as acting dean of the College of Engineering of the University of Illinois during the absence of Doctor Goss.

E. G. Bradbury, consulting engineer, Columbus, Ohio, has been appointed sanitary engineer of Franklin County, Ohio. He will have charge of all sewerage construction within a radius of three miles of Columbus. He is the second county sanitary engineer to be appointed in Ohio, L. A. Boulay, handling the Toledo district for Lucas County, being the first sanitary engineer so employed.

George W. Cooley, state engineer and secretary of the State Highway Commission of Minnesota for 11 years, has retired from active service.

Jay A. Craven, assistant engineer, Terre Haute Water Co., has been nominated by the Indiana State Board of Health as a member of the Indianapolis Board of Sanitary Commissioners, which is to construct a sewage-disposal plant for that city. B. J. T. Jeup, city engineer, is the ex-officio member of the board, and these two men are to select the third member under the provisions of an act of the recent legislature.

Dr. W. F. M. Goss, dean of the College of Engineering, director of the School of Railway Engineering and Administration, professor of railway engineering at the University of Illinois since 1907, and director of the Engineering Experiment Station of that university since 1909, has resigned to become president of the Railway Car Manufacturers' Association of New York. Doctor Goss organized the department of practical mechanics at Purdue University in 1879, subsequently serving as instructor and professor of practical mathematics, professor of experimental engineering, dean of the schools of engineering and director of the engineering laboratory at Purdue, leaving there in 1907 to join the faculty of the University of Illinois. Doctor Goss was a member of the Jury of Awards at the Chicago World's Fair, and chairman of the Advisory Committee of the Pennsylvania Railroad Co. charged with testing locomotives at the St. Louis Exposition. He was chief engineer of the commission on smoke abatement and electrification of railway terminals at Chicago from 1913 to 1915. Doctor Goss' address is 61 Broadway, New York City.

Isham Randolph, consulting engineer, Chicago, Ill., is at the head of a citizens' committee to promote the organization of a regiment of engineers for the Illinois National Guard to be located in Chicago. The state legislature is being appealed to for the enactment of a law authorizing an increase from the one company now in existence up to a whole regiment of six companies.

Albert Freitag, civil engineer, has left the service of the Little River Drainage District at Advance, Mo., and is now with James O. Heyworth Co., contractor, Indiana Harbor, Ind., on the construction of an ore dock in that city.

S. D. Newton, civil engineer, Charlotte, N. C., has been engaged as city engineer of Cleveland, Tenn. Mr. Newton was formerly city engineer of Knoxville, Tenn., but for the past three years has been engaged in private engineering practice.

B. F. Francis, assistant superintendent of bridges, Pennsylvania division, Pennsylvania R.R., stationed at Jersey Shore, has been made supervisor of bridges and buildings at Rochester, Pennsylvania.

W. H. Vance has been appointed engineer of maintenance-of-way of the St. Louis Southwestern Railway Co., with office at Tyler, Texas.

Charles U. Freund, chief engineer, Illinois & Central Michigan Canal Commission, until the appropriations were exhausted last year, has been made engineer in charge of water transportation of the Keystone Steel and Wire Co., Peoria, Ill. Mr. Freund has recently been engaged in special investigations for the Chicago Commission on Ventilation.

Victor Wierman, superintendent of the Trenton division of the Pennsylvania R.R. since 1912, has been transferred to the office of the general superintendent of the New Jersey division at New York City.

F. W. Smith, Jr., assistant superintendent of the New York division of the Pennsylvania R.R., has been promoted to the superintendency of the Cresson division.

Reid Tull, of Spartanburg, S. C., resident engineer of the Piedmont & Northern Ry., has been elected highway engineer of Spartanburg County, at a salary of $3000 a year. He will have the supervision of road construction in that county.

Addison J. McCune, consulting engineer, Denver, Colo., has been appointed state engineer of Colorado. Mr. McCune served as state engineer from 1899 to 1903, since which time he has been engaged in irrigation and general consulting practice.

Price Advances Expected To Continue

Contractors' Men and Equipment May Be Kept Busy Even Though Some Classes of Work Greatly Decline

It is believed that prices of construction materials will continue to advance slowly, in spite of the fact that the war is expected to check the inflation of currency and credit in this country, and to curtail the consumption of some classes of construction materials by lessening the amount of new work undertaken. The commodity index kept by the London "Economist" has doubled since August, 1914, while that kept by Bradstreets' for the United States has increased but 70 per cent. in the same period. The resources of this country are, for all practical purposes, to be pooled with those of our Allies, and prices here and abroad may be expected to approach each other until they are at the same level, when further slow advances may occur. While it is true that the prices of important construction materials are not included in these indices, it is also true that the price advances which are recorded by them are part of a broad upward movement affecting practically all commodities.

It has been pointed out before in these pages that increases in the cost of most American construction materials have been due more to the labor shortage and the increasing cost of production than to excessive demand. The extraction of 2,000,000 men from American industries may have a still more marked effect in this direction unless the principles of scientific selection are extended to make possible reasonable production costs in some of the industries supplying materials for construction work.

Decline in New Building Looked For

Undoubtedly the volume of residential, apartment and business building construction will be far less than would have been expected under other conditions. Much of the money which would have financed such operations will undoubtedly be invested in the government loans. The contractors engaged in such operations may be expected to drift even more markedly than in the season of 1916 into the construction of industrial buildings for the production of materials demanded by the new conditions which confront us. It is likely that from the ranks of these contractors can be drawn the largest percentage of men for engineer troops with the least disturbance to necessary construction work. The fact that nearly all of the first $7,000,000,000 war loan will be spent in this country is expected to stimulate manufacturing production still further, which indicates that it will be necessary for contractors engaged in constructing industrial plants to continue the sort of work on which they are already engaged. It is likely to prove necessary to carry out important construction work on transportation lines, and to continue highway improvements. Moreover, the organizations of several of the large general contractors are already proving valuable to the government on special work, and it is expected that many more of these firms will be working directly for the country as civilian organizations before the end of the construction season.

Construction Plant To Continue at a Premium

The raising of a large fighting force, the further stimulation of production in many lines, and the pressing necessity for increasing the supply of farm labor will force a redistribution of the labor forces of the country from which the contractor can hope to gain but little. Many men from the construction ranks will doubtless go directly into military service. In view of such conditions, even though the volume of work undertaken should decline considerably, there is no doubt that the use of mechanical equipment will continue very profitable wherever it can be employed, at least until the end of the war.

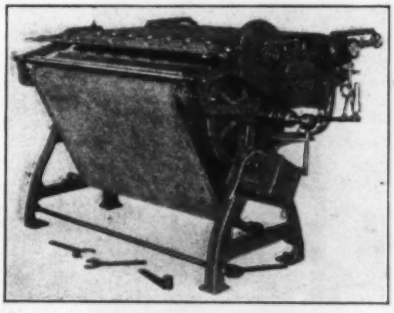
Money Situation Peculiar

In view of the vast sums of money required by the Federal Government, it is probable that state and municipal authorities will postpone a major part of the local improvement work until a more favorable opportunity. This may not apply, however, to highway work or other construction which would directly benefit agriculture or manufacturing production. While capital for carrying out new enterprises is likely to become very scarce within a short time, contractors on the other hand should have little difficulty in financing their own operations where short-term loans are involved. Most of the money raised by the government will be spent at home, and a large part of it will be deposited with the Federal reserve system in such form that it can only be loaned out on short-term notes, thus keeping up the supply of funds for this purpose while diminishing the capital available for permanent investment.

Appliances and Materials

Machine Washes, Dries and Irons Prints

Paper and cloth blueprints are dried and ironed by a machine, shown in the accompanying illustration, made by the American Laundry Machine Co., of Cincinnati. The machine consists of a heated cylinder 20 in. in diameter, supported by iron end frames held together by means of tie-rods. A fabric apron is used to carry the prints (taken directly from the washer) underneath the cylinder and around to the top, at which point they ride over the curved metal fingers and are carried out to the receiving end. The prints emerge bone dry. If a printing machine of the revolving-cylinder type is used, the entire operation of printing, washing and drying may be carried out in rolls.



BLUEPRINTS ARE WASHED, DRIED AND IRONED IN ROLLS

The machine is built in two sizes, 40 and 60 in. wide, and may be heated by gas, steam or electricity. Either belt or variable-speed-motor drive is used, as desired. The larger machine occupies a 66 x 78-in. floor space and weighs 1825 lb. Its capacity is upward of 45 sq.ft. per min.; it requires 55 cu.ft. of gas per hour or 11-kw. electric supply or 1½-hp. steam-boiler capacity.

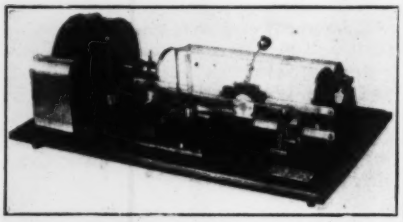
Holder Yoke Connects Meter to Vertical Pipe

A new design of yoke for holding water meters and connecting them into a vertical pipe has been placed on the market by the Ford Meter Box Co., of Wabash, Ind., under the name "Ram-Horn." It is virtually a cross fitting with a diaphragm and curved arms which lead water to and from the meter and hold the latter in place.

Distant Stage Recorder Adapted to Telephone

The utility of the Stevens distant water-stage recorder has been increased by making it work over a telephone line without interrupting communication. The old machine required two circuits and three special wires, over which impulses were sent in response to the movement of the stage-measuring float. A receiver and recorder were mounted on one bedplate, and in place of the float pulley on the shaft of the spine wheel which drove the pencil carriage, there were fixed two ratchet wheels with opposed teeth. Playing over these ratchets were pawls carried by loose arms on the spine-wheel shaft. One or the other of these arms was pulled down by a solenoid whenever the proper circuit was closed by the sender. The ratchet wheels were moved each time a distance proportional to one stage interval, and the pencil carriage moved to the right or left to record the change in water level.

On the new machine the sender remains the same, except that it sends the current in one direction for rising stage and in the reverse direction for falling



STAGE RECORDER WORKS OVER TELEPHONE LINE

stage. The sending ends of the telephone circuit are joined by a repeating coil through which the sender connection is made, so that the disturbance is balanced and no effect produced on the telephone. At the distant end, a polarized relay is connected to a repeating coil. This sends current from a station battery to one or another of a pair of solenoids on the receiver and works the ratchets as already noted in the older machine. This apparatus was designed by J. F. Stevens, consulting engineer, Portland, Ore., and is made by Leupold, Voelpel & Co., of Portland, Oregon.

New Locknut Has Clamping Fingers

One of the latest forms of locknuts to be placed on the market is that bearing the trade name "Drake" and manufactured by the Western Screw and Locknut Co., of San Francisco. The device consists of two half-nuts. The lower half is provided with a cylindrical projection that has its end beveled, and this projection is slotted so that it has six fingers. The upper half of the locknut is recessed to receive the fingers on the lower half, and it is shaped so as to jam the fingers down, causing the lower half to grip the bolt.

Improved Backwater Valve Seals Waste-Pipes

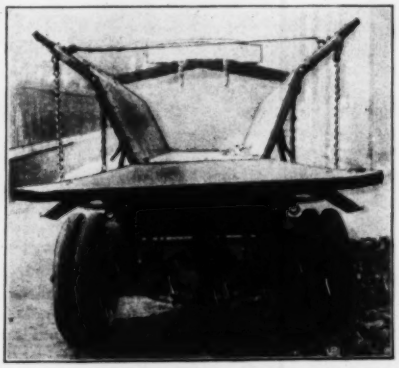
Under the trade name "Pennie Backwater Valve," the Kennedy Valve Co., of New York, is putting out an im-

NEW CHECK VALVE HAS BALANCED DISK

proved check for sealing the waste-pipe sewer connections from residences, public buildings and public-utility manholes. The closure against backflow is effected by a balanced bronze and cast-iron disk, which fits against a brass seat. The operation can be made positive in any position by fastening lead in the counterweight cup, although no such loading is required for installation in a horizontal pipe line. For vertical or inclined lines, melted lead is poured into the cup. This valve fits either standard or extra-heavy soil pipes, and is made in all sizes from 2 to 12 inches.

Lee Dumping Body Can Be Kept Busy

An addition has been made to the well-known line of dumping bodies for handling loose material, made by the Lee Loader and Body Co., 2343 South La Salle St., Chicago. The general-utility body was devised to meet the demands of contractors who desired a dumping body of the Lee type, but one that could be kept busy continuously. The points of difference between the new and the older body are the flat floor and the hinged end gate. The side-dumping feature of the old body has been retained, the difference in shape being compensated for by increased curvature in the rolling rails. The new type is built in all sizes from 1- to 6-yd. capacity or over. The accompanying illustration shows a 3-yd. body on a 3½-ton Standard truck.

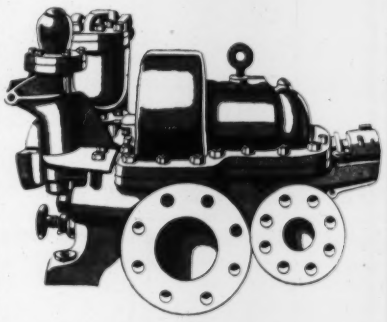


SIDE-DUMP MOTOR-CAR BODY HAS FLAT FLOOR

New Boiler-Feed Pump Saves Room

A new design of boiler-feed pump made by the De Laval Steam Turbine Co., of Trenton, N. J., is illustrated herewith. A centrifugal pump is mounted on the same shaft with a velocity-stage steam turbine, and both machines are inclosed by one casing. The new unit weighs about one-tenth as much as a duplex pump for equal delivery.

The impellers are of bronze; two are used for pressures of up to 200 lb. per sq.in., and three for above that. Each impeller discharges into a volute chamber, no diffusion blades being used. The runner is hydraulically balanced, the balancing chamber being vented between a collar on the casing and one on



TURBINE AND PUMP IN SAME CASING

the shaft, so that the clearance is automatically adjusted. The pump suction is next to the turbine exhaust, so that simple shaft packing can be used.

The steam end has two or three rows of buckets, according to the desired steam economy. The nozzles are proportioned variously—for high-pressure steam exhausting to feed heater or condenser, for low-pressure steam exhausting to condenser or for interchangeable service. The unit has a constant-speed governor, auxiliary to a feed-pressure governor. The bearings are of the straight ring-oiler type.

New Kiln-Fuel Feeder Uses Low-Pressure Air

The pulverized-fuel feeder and commingler designed for locomotive service by the Locomotive Pulverized Fuel Co., of New York City, has been adapted for cement kilns. The feature of greatest interest is stated to be the low air pressure (8 oz.) employed in contrast with the high pressure (80 lb.) generally used. A saving on that account of 160 hp. is claimed for each 1000 cu.ft. of free air delivered. This feeder can be used with the existing pulverized-fuel installation. A feed screw in a fuel trough below the bin is driven by a 2-hp. 3: 1 variable-speed motor. The fuel and air are delivered through separate but concentric openings to a mixing chamber in which are paddles on an extension of the feed screw. A delivery elbow connects to the kiln feed line